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SCIENCE.

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FRIDAY, JULY 6, 1883.

FIELD-CLUBS AND LOCAL SOCIETIES.

Within the last twenty years there have been a good many experiments made in this country towards the development of science in districts where access to public instruction, in the way of lectures and large museums, was not to be had. Some of these efforts have been successful, but many of them have failed, principally from a want of understanding of the conditions that make success possible. There are few country towns, in this or any other land, where it is possible to maintain an academy patterned on the great societies. Such institutions can only do good when they are sure of the support of many earnest workers, — of men to whom science is a matter of all-absorbing interest. Very few *societies* can be maintained without a system of publication which is very costly, and often of no measure of utility compared with their expense.

To make a society successful there must be a distinct object for it to attain, — one which is well within the reach of such efforts as its members can bestow upon it. The success must be of a tangible sort, — one that is constantly and readily attainable, and in which many can take an active part. In the great societies of the world, this end is honor, or at least notoriety, that may simulate the nobler motive. In a village, a town, or even a provincial capital, neither of these ends can be had with sufficient certainty to secure the talent that is open to temptation. So the local society languishes, or, doing better by itself, dies out altogether.

There is another form of associated action among the lovers of science that escapes the dangers of the more pretentious associations which take the name of society or academy. This is found in the field-club or purely local society, which proposes for itself the study of the problems that lie at the very thresholds of its people. Such associations have already proved wonderfully successful in the old world. They abound in England, and are numerous on the continent. They have found a place in the affections of the people, and a certainty of continued life, where academies have dwindled away.

We do not have to look far into human nature to see why this success has been gained. It is happily natural for men to take more interest in near than in remote things. The primrose by the 'rivulet's brim,' provided it is one's own rivulet, is more interesting than the Victoria regia of far-off wildernesses. The geology of the township where a man lives is more interesting than that of the Colorado cañon, which has never concerned him. So it is that any association for the study of near things has a certainty of support that cannot be secured for any general work in science; and field-clubs which try to promote the study of a township, or at most of a county, are likely to find a support that surprises their founders.

Then, if the proper method be followed by these clubs, there enters into their life an element of the holiday which is very far from the senatorial methods of the more dignified society. Their meetings should be principally in the outer air; for they thus secure the best that the study of nature can give, something of the freshness of woods and field, and the cheerful contact with other fellow-mortals beneath the open sky, — a relation that has a charm that is denied within four walls.

Wherever there is a single zealous student of nature, there is the germ of such an association. He or she can easily gather together a dozen of boys and girls, men and women, who will find in open-air inquiry a rich reward for all the time and force that such activity demands. There should be as little of the machinery of a society as the circumstances will admit: a council of three to five persons to direct the scheme of studies, and a secretary, will serve all the first needs of the association. A few winter-time meetings will find an interest in the discussion of the problems that the neighborhood affords, in the review of work that has been done, and of work there is to do; but the most of the work should be done in the field-meetings.

When there are enough engaged in the work to warrant it, it will perhaps be well to have particular inquiries placed in special hands. Each field-meeting should be for some particular end or ends; and, after the field-work is done, the members should be gathered together, still by preference in the open air, for a discussion of the results obtained.

In those cases where the circumstances admit, it is well for such a society to begin the making of a little museum devoted to the illustration of the field with which they have to deal. The cost of such a collection need not be great; and the utility of the work is very great, provided it be not too much of a burthen to the association. It would best not be undertaken unless the club can see its way to a well-assured income of at least five hundred dollars per annum, beyond the rent of a room where it is deposited. Generally it will be possible in towns of any size, and where public spirit reigns, permanently to secure a room in some schoolhouse or library building, large enough for the needs of the little museum. The walls of a room twenty by thirty will serve for the storage of specimens for many years, and its floor-space will be great enough for meetings in the winter months.

The first thing to be secured is as good a map as can be obtained, on a tolerably large scale, of the region to be studied; for the awakening of the geographical sense of the members is one of the best results that can be obtained by a field-club. In proper time this map can become the place of record of a great deal of fact which cannot be represented by the specimens that may be gathered from the field that it represents.

The five hundred dollars' revenue upon which such a collection should always rest will serve, with due economy, to provide shelves for the collections, to meet the cost of alcohol, bottles, etc., and pay the trifling other charges of the society.

While it is best that the work of such a society should be thoroughly autonomous, — that the motive for its prosecution should come from the people themselves, — it will at times be well to secure the aid of some one specially trained in such problems as its field affords, in the way of suggestions concerning work to be done. Many naturalists will be glad to give aid in this way, either by a lecture, or by written advice. Every field affords problems in geology, botany, entomology, etc., the solution of which is within the limits of the simplest research if it only be patient and truth-seeking in spirit. More of the future of natural history lies in the prosecution of such inquiries than in all the work that can be done in the closet.

Such collections, as soon as they are begun, will at once command the attention of working naturalists. They are sure to be visited and studied; and this interest they arouse will, in itself, pave the way to a quickened life, and better inquiry on the part of the members of the club.

When these societies become numerous enough, — when there are a dozen working in New England, for instance, — it will be well to have a little joint action among them, such as could be obtained by an annual meeting of representatives from them, for the discussion of methods and of problems to be jointly investigated. The interesting experiment of a state meteorological system in Missouri has shown how useful local observers can be in this science. It might be well for the societies to arrange for some common system of observation in this branch. So with each of the sciences: conjoint action would solve many problems that are of the highest interest.

Then, again, there would be a great influence on the extension of science-teaching in the public schools, that would certainly come from the existence of such local societies. The greatest danger that now menaces natural science is, that the parrot system of teaching, so long applied to other branches of learning, will be taken in science-teaching. The presence of a little band of actual inquirers in any town will be the best possible assurance against this. Let the children have some share in the open-air actual study, and the evil of the book-system will surely be mended in part: for its imperfections will be seen.

It will often be possible to organize such a club in immediate connection with the schools of the town where it started. Experience in Europe shows that children readily and zealously engage in such inquiries, and need only a little direction in their work.

However we look at it, we see much to hope from the extension of the field-club system of science study.

THE NATIONAL RAILWAY EXPOSITION.

I.

THE exhibition of railway appliances now being held at Chicago is probably the most complete collection of all the varied apparatus used in every department of railroad working and construction that the world has ever seen; and the management are to be congratulated, that, while little has been omitted to make the show complete, still less has been included which is foreign to the subject of railroads. The exhibits range over a wide field, from uniform-coats to steel rails, railroad officers' desks to revolving snow-ploughs, and from an electric railroad in full working, and earning quite handsome traffic receipts, to George Stephenson's first locomotive, which is shown by an English railway company.

The main questions which are now awaiting solution in the railway world are well represented in the exposition. The cheap transport of heavy freight-trains over steep grades, the conveyance of perishable articles, such as meat and fruit, and the control of the *vis viva* or momentum of trains, are all questions which have to a certain extent been solved; and further developments of these solutions are shown. A locomotive of unprecedented size and power, fitted with a valve-gear of novel construction, which yields excellent results, is shown by the Southern Pacific railroad, and a large number of fine engines are shown by the Brooks and other locomotive works. The exhibition of refrigerator cars is very complete, and most of them appear to be of simple and efficient design. Continuous brakes, applicable to freight-trains, are exhibited; and as some of them appear worthy of careful examination, we shall refer to them later on.

While there can be no doubt, that as regards cheapness and rapidity of construction, general excellence of bridges, locomotives, and cars, the railways of this country are ahead of the rest of the world, the signalling arrangements here, with few exceptions, are rudimentary and inefficient, and render fast travelling a matter of considerable difficulty, if not danger. It is impossible to run a really fast express-train if the signals are ambiguous, and if every level crossing is made a compulsory stopping-place. The saving in time by fast trains can only be fully felt in a great country, where very long journeys are not only possible, but are frequently undertaken; but hitherto this fact has been little appreciated, and people have been content to travel at a slow speed, and put up with frequent stoppages, because the railways were new, the rails roughly laid, and many bridges unsafe at a high speed. But of late years these conditions have been materially changed. The wide-spread use of steel rails, the greater care bestowed on the road-bed, and the introduction of iron bridges of first-class workmanship, have rendered high speed perfectly safe and easy on most parts of good roads in the eastern and middle states; but it is rendered unsafe where switches are so arranged that they may be left open to an approaching train without any signal warning the engineer, or the signals are so formed that the difference to the eye between a clear or all-right signal and a danger or stop signal is slight in snowy weather or under certain atmospheric conditions which render the difference between colors imperceptible, though a difference in form may be perceived.

The exposition is, however, especially strong in signal apparatus; and there can be little doubt that the most important result of the exhibition will be the wide-spread adoption of some of these safety appliances, rendered necessary by the increased number of trains, and the fact that the thicker and more numerous population now demands both safer and faster travelling. The real gain of time to a business-man, obtained by a difference of a few miles an hour in the speed of a long-journey train, is best illustrated by an actual case, — a man in New York who wishes to do a day's work in Chicago. He takes one of the fastest and best appointed trains he can find, — the Chicago limited. It leaves New York at nine A.M., and lands him at Chicago at eleven the next morning, having accomplished nine hundred and eleven miles in twenty-six hours fifty-five minutes, allowing for the difference in time between the two cities. This makes an average speed of 33.8 miles per hour, including all stoppages. But assume, what is surely not extravagant, that as high a speed can be attained on the Pennsylvania or any other first-class American road as on an English main line, and what shape does the problem assume? On one English road, the Great northern, the distance between Leeds and London (a hundred and eighty-six miles and three-quarters) is done in three hours forty-five minutes, including five stoppages; on another, the Great western, the hundred and twenty-nine miles and three-quarters between Birmingham and London is run in two hours forty-five minutes, including two stoppages; and as neither of these routes is particularly level or straight, and both pass through numerous junctions with a perfect maze of switches and frogs, they give a fair idea of what is possible in speed on the railroads of this country. These figures give, respectively, speeds of 49.8 and 47.2 miles per hour. Taking as a fair average forty-eight miles an hour, including stoppages, the journey from New York to Chicago should be done in eighteen hours fifty-nine minutes, or, say, nineteen hours, — a saving of seven hours fifty-five minutes on the present time; so that, if the train were arranged to leave at fifty-five minutes past four in the afternoon instead of nine o'clock in the forenoon, the whole of this time would be saved in the busy part of the day, effectually adding a day to our imaginary traveller's business and dollar-making life.

It may be thought that such a deduction is unfair, as the English style of car is so much lighter than the American; but, as a matter of fact, the average English express-train is considerably heavier than the Chicago limited, and conveys about three times the number of passengers; and, as trucks and oil-lubricated axle-boxes are not yet universal there, the tractive resistance per ton is probably higher. It certainly, therefore, seems not only possible, but feasible, to attain these high speeds in this country, where, owing to the long distances to be travelled, they are more valuable than in England; and the great step towards attaining that end is the adoption of proper and efficient signalling arrangements. All the other steps are achieved: the American passenger locomotive of the present day is perfectly competent to drag a heavy train at a speed of over sixty miles an hour; the cars, as now constructed, can travel safely and smoothly at that speed; and the steel rail, the well-ballasted tie and perfect workmanship of the modern iron bridge, can well support the thundering concussion of an express-train at full speed. But this speed can only be maintained for a few miles at a time if the engineer who guides this train be doubtful whether that dimly-seen signal imply safety or danger, or if the laws of the state bring him to a full stand where his road is crossed by a small corporation with a high-sounding title, which owns one locomotive with a split tube sheet and two cars down a ditch.

To run a fast train, a clear, uninterrupted road is absolutely necessary; and the reason is not far to seek. To move a body from a state of rest to a velocity of sixty miles per hour or eighty-eight feet per second, an amount of work must be performed equivalent to lifting that body a hundred and twenty-one feet. Now, it is apparent to the simplest capacity that it requires a pretty powerful engine to overcome the resistance of a train running at sixty miles per hour without every few miles putting on brakes to destroy this velocity, and then to lift it a hundred and twenty-one feet again to attain speed; the resistance of the air, and the friction of bearings on journals and of flanges against rails, going on all the time. As a matter of fact, showing what severe work this is on an engine, the Zulu express on the Great western railway of England, which is the fastest train in the world, has been repeatedly carefully timed; and it is found, that, though running over an almost absolutely level and straight road, it takes a distance of twenty-six to twenty-eight miles to attain its full speed, about fifty-eight miles and a half an hour.

The adoption of a safe and thorough system of signals, efficiently warning the engineer of a train of any danger in his path, whether from a misplaced switch, an open draw, or a freight-train ahead, may be regarded as of great importance to the American railroad system, in a manner crowning the edifice, and enabling roads to be operated with greater speed, safety, and regularity.

(To be continued.)

THE INFLUENCE OF GRAVITATION, MOISTURE, AND LIGHT UPON THE DIRECTION OF GROWTH IN THE ROOT AND STEM OF PLANTS.

Members of my present botany class have performed some experiments this spring, bearing upon the above caption, which, although not developing any thing new in the interest of the extension of experimental methods in the lower schools, it seems to me may be found worthy of a record in the columns of Science.

Seven balls of moss, about four inches in diameter, were prepared, in the centre of which were planted from fifty to a hundred grains of oats, barley, or corn; in some cases a mixture of two of these grains.

No. 1 was suspended in free air, lighted on all sides. No. 2 was placed on a glass tumbler, in the bottom of which some water was kept, but not enough to rise within two inches of the lowest part of the ball. No. 3 was fitted into the mouth of an inverted bell-glass in such a manner that one half of the ball was within the jar and one half without it. No. 4 was placed one half within and one half without a bell-glass placed in a horizontal attitude. No. 5 was in a tight tin can, the ball fitting it like a stopper, so as to exclude the light and to prevent a circulation of air. One-half of the ball protruded from the can, and the can was inverted. No. 6 was placed in a can similar to that of no. 5; but this was placed in a horizontal attitude, as in no. 4. No. 7 was mounted upon a spindle running through its centre. The spindle was attached to the stem of the minute-hand of an eight-day clock in such a manner that the axis of the spindle was a continuation of the axis bearing the minute-hand of the clock. The spindle was a piece of one-eighth inch brass wire having a strip of tin soldered to one end of it. The tin was perforated with a square hole, exactly fitting the shaft of the minute-hand of the clock. The other end of the wire was filed down to form a small journal, which worked in a hole bored in a lump of solder secured to the end of a wire which acted as a support to the distant end of the spindle. This supporting wire was first bent double, forming a narrow V, and the solder, which served as a box for the journal, dropped in the vertex. The two arms of the V were then bent upon themselves in the same direction so as to form a right angle with the plane of the V. Two holes were bored in the frame of the clock above the dial, but close to it, and the arms of the bent V inserted. The minute-hand was then removed from the clock, and also the washer behind it. The tin shoulder of the spindle was then placed upon the shaft, and the minute-hand replaced; the shoulder serving in the place of the washer, which had not been replaced. It was only necessary to shorten the pendulum a little to enable the clock to record time with its usual regularity.

The results observed after germination were as follows: —

In no. 1 the stems all came out in a clump at the top of the ball, and the roots in a cluster from the under side. The roots, however, after protruding from half an inch to an inch, curved upon themselves, and re-entered the ball, or else withered. In no. 2 the stems all came out at the top, and the roots at the bottom; but the roots in this case continued straight downward into the water, no one of them turning back into the ball. In no. 3 the plants deported themselves in all respects as those did in no. 1, except that the growth was very much more rapid. In no. 4 all of the stems except two came out of the ball into free air: two grew horizontally into the bell-jar. A large cluster of the roots came out of the ball and entered the jar, and continued to grow horizontally, only depending so much as was necessary by their own weight. Others of the roots emerged from the lower side of the outer half of the ball, but soon entered it again. In no. 5 all of the stems came up in the dark, damp atmosphere; and the roots emerged from the lower side of the ball, but re-entered it again, or else perished. Many of the stems (oats in this case) threw out a pair of opposite bodies, apparently secondary rootlets, which grew horizontally, in all cases observed, to a length of about one inch. The color of the stems in this case was a pale yellow. In no. 6 all of the stems came from the ball upward into the light, and very many of the roots protruded horizontally into the can, some of them leaving the ball above its centre. A corn-root extended itself horizontally four inches beyond the surface of the ball, and in that distance was only depressed one-half of an inch. On the corn-roots back of the sensitive tips, the delicate root-hairs were so numerous and long as to give it a resemblance to the hair-brush for cleaning lamp-chimneys. In this ball a number of roots also emerged from the lower side of the ball, but only to re-enter it again, as in the other cases. In no. 7 stems and roots came out together indiscriminately, and from all sides of the ball; the roots, however, after protruding from half an inch to an inch, re-entering the ball or withering. This experiment was twice repeated. In the first case more stems appeared from the side of the ball away from the face of the clock, and the greater number of roots made their appearance on the opposite side of the ball. It was observed in this case, however, that the spindle slanted about two degrees toward the clock. In the next experiment the spindle was made horizontal, and no difference as to place of emerging of root and stem was observed.

These experiments in combination appear to show with clearness the influence of moisture and gravitation in determining the course of the root, and to suggest that the influence of moisture is the stronger of the two.

The emergence of the sensitive tips of the primary roots from the damp ball into the dry atmosphere I suppose Darwin would have explained as the result of the persistence of the impressions in the root behind. The horizontally extending roots in the damp atmosphere, both dark and light, suggest that the response to gravitation in both cases was *nil*. May it not be true that the diageotropism of roots is such in no other sense than that of direction of growth? that it is in reality simply a growing toward the proper amount of moisture? This would appear to explain the oblique direction of secondary branches, and the largely indifferent direction of tertiary ones. The balls in the jars placed in the horizontal attitudes indicate that the stem does not grow simply in a direction opposite to that of the principal root, for they were turned toward each other through an angle of nearly ninety degrees. The two inverted jars show that the stems did not seek a dry atmosphere, for in both cases they grew up into that which was more moist. The inverted dark jar shows that the effect of the impact or absorption of light on the lower half of the ball, and the absence of these effects upon the upper half, did not produce a sufficient contrast to guide the stem into the light; but since, of the two jars placed in the horizontal attitude, only the ball in the mouth of the glass one sent stems into the jar, it seems possible, since other conditions were alike, that light may exert a small influence in guiding the stems from the ground. F. H. KING.

River Falls, Wisconsin, May 17, 1883.

SOME GLACIAL ACTION IN INDIANA.

WITH members of my class in geology, I have been examining the glacial deposits in this vicinity (Montgomery county). Our chief water-course is what is called Sugar Creek, a tributary of the Wabash River, which occupies a valley with a general south-westerly bearing, virtually the same trend which the Wabash has across the state before it makes its sharp bend to the south. Along the valleys of the Wabash and Sugar Creek, there are abundant evidences of a glacier which moved in the direction of the valleys, and is known as the Lake Erie glacier, as it advanced in the direction of the axis of that lake, and so up the Maumee, and across the low divide at Fort Wayne, into the Wabash. Sugar Creek itself has been compelled to bend sharply to the south a few miles to the west of us by the deposits of this old glacier, and has cut its new channel through the soft subcarboniferous sandstone. At one place in this county, where the creek still occupies its preglacial valley, it cuts through what we formerly considered a large terminal moraine, which lies squarely across the valley. Recent floods have swept away some of this moraine, and laid bare the country rock. This rock is found to be smoothly planed, and absolutely covered with glacial scratches all trending N. 20° W., or almost at right angles to the valley of the creek and the course of the former glacier. These scratches of the second glacier are now found in many places throughout the county; and our old terminal moraine proves to be a medial moraine, and bears upon its back a line of huge bowlders with the same northwesterly trend. These facts are recorded here in the hope that they may be of some use in the consideration of a much-vexed question.

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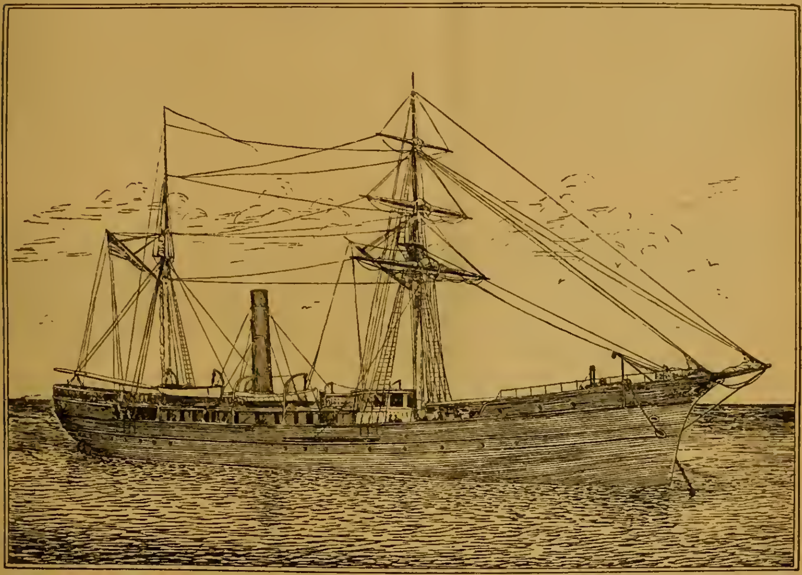
THE UNITED STATES FISH-COMMISSION STEAMER ALBATROSS.

I.

PROBABLY no department of scientific investigation has made greater progress in its methods of work during the past ten years than that of deep-sea research. The successful introduction of steel piano-wire for sounding, and of wire rope for dredging purposes, marks a new era in this class of exploration, for which credit is mainly due to American skill and energy. While claiming so much in behalf of our own country, we frankly acknowledge that the only feasible method of using sounding-wire was devised by one of the best known of English physicists, Sir William Thomson; but his efforts were entirely ignored by the mother government, and first bore fruit on this side of the Atlantic, through the liberality of the American navy.

It is needless in this connection to discuss the rapid development of this system of deep-sea sounding, which has been so fully described by its most zealous advocates, Messrs. Belknap and Sigsbee, of the United States navy. We may be pardoned, however, for recalling the fact, that it was early in 1874 that Capt. Belknap made his famous sounding-voyage across the Pacific Ocean in the U. S. S. Tuscarora, while the Challenger was still plodding its way around the world with its cumbersome hempen rope, one of the Thomson machines being carefully stowed below. Since then Commander Sigsbee has so perfected the sounding-machine, on the proper working of which success with wire depends, that further improvements seem impossible.

The use of wire rope for dredging was suggested by Mr. Alexander Agassiz, under whose supervision it was first put to trial on the coast-survey steamer Blake in 1877. To Messrs. Sigsbee and Agassiz, and the officers of the Blake, is due the greater number of improvements in deep-sea dredges, trawls, and accessories to sounding, which are now employed on the American coast; while the U. S. fish-commission claims priority as to the appliances for moderate depths of water, although many of these are yet to be thoroughly tested in the deeper parts of the ocean.

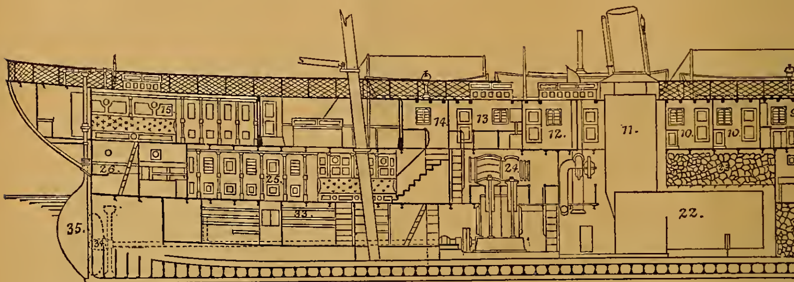


UNITED STATES FISH-COMMISSION STEAMER ALBATROSS.

The great desideratum in marine explorations has always been suitable vessels for properly carrying on the work in all its branches. Our coast-survey, however, is gradually building up a fleet of steamers which are admirably adapted to their special field of surveying and sounding; and several of these, among which we may name the Blake, the Hassler, and the Bache, have already rendered distinguished services in the line of deep-sea dredging and trawling. The latest addition to our exploring-fleet has been the construction of a thoroughly sea-going steamer for the express purpose of investigating our maritime fisheries, in both a scientific and practical manner, by means of every known appliance suited to the work. This new undertaking is but an advance step in the progressive work of the U. S. fish-commission, under the able and judicious management of Professor Baird, and was demanded by the urgent necessity for a more extended knowledge of our off-shore fishing areas. The initiative in this direction was taken some three or four years ago, when Congress sanctioned the building of the steamer Fish Hawk, in the combined interests of fish culture and exploration. Previously, small naval steamers had been adapted to the requirements of the fish-commission as their services were needed; and, considering the pioneer character of their work, they rendered valuable aid.

In associating fish-culture with scientific investigation, some sacrifice had to be made at the expense of one or other of these projects; as no steamer, built to enter the shallow rivers and indentures of our coast-line, could venture with safety to any distance from land. Fish-breeding was at that time considered the more important; and the Fish Hawk, with her shallow draught of water, must confine her operations to the vicinity of the coast; and yet, from a perusal of recent papers in this journal by Professor Verrill, it will be seen that her contributions to biology have been surprisingly great. The Albatross, however, as the new steamer has been christened, will, like her namesake, make her home upon the high seas, chasing schools of fish, or diving beneath the surface with the dredge and trawl.

The Albatross is a twin-screw propeller, rigged as a brigantine, and was built at Wilmington, Del., during 1882, by the Pusey & Jones Company, who were also the builders of the steamer Fish Hawk. She was designed by Mr. Charles W. Copeland, consulting engineer of the U. S. lighthouse board; and her entire construction and subsequent preparation for service have been under the immediate supervision of her present commander, Lieut. Commander Z. L. Tanner, U.S.N. The launch was successfully made Aug. 19; and the work of fitting up the various quarters and of arranging the scientific appliances was rapidly pushed to completion. The trial trip began Feb. 9, 1883; and at the time of writing she is making her first long cruise.



LONGITUDINAL SECTION OF UNITED STATES FISH-COMMISSION STEAMER ALBATROSS.

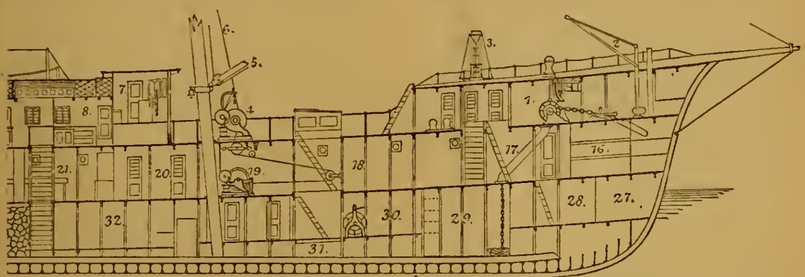
1. Topgallant forecastle; 2. Fish-davit; 3. Sigsbee sounding-machine; 4. Dredging-engine; 5. Lower end of dredging-boom; 6. Dredge-rope; 7. Pilot-house; 8. Chart-room; 9. Upper laboratory; 10. Naturalists' staterooms; 11. Steam-drum; 12. Galley; 13. Upper engine-room; 14. Entrance to wardroom; 15. Poop-cabin; 16. Storerooms; 17. Fore-passage; 18. Berth-deck;

In the construction of the Albatross, several novel features in marine architecture have been introduced; as past experience has proved that the ordinary form of hull is but poorly suited to the work of deep-sea dredging and trawling. The most important modification is at the stern, which has been sharply modelled to enable her to back readily and safely in a seaway, her usual method of propulsion while engaged in this class of work. The rudder and its attachments have also been made of extra strength to withstand the hard service to which they are thereby subjected.

The greatest length of the vessel is two hundred and thirty-four feet; and the length at the ordinary water-line, with a draught of twelve feet, two hundred feet. The breadth of beam moulded is twenty-seven feet and a half. The registered net tonnage is four hundred tons, and the displacement on a twelve-feet draught, a thousand tons. The frame-work and hull are of iron, which also enters largely into the construction of the deck-house. Forward and aft, the iron sides extend to the level of the upper deck to enclose the poop-cabin and top-gallant forecastle, while in the intervening space they form a high protecting rail to the main deck. The deck-house (7–14), which is eighty-three feet long, thirteen feet and a half wide, and seven feet and a quarter high, extends from just forward of the mainmast nearly to the foremast, leaving an ample passageway on either side between it and the rail. The after-part is built of iron, with wooden sheathing; but forward of the funnel it is entirely of wood. followed by the steerage (20), main laboratory (21), engine and boiler compartments (24, 22), which extend into the hold, and the ward-room (25).

The forehold contains the magazine (27), water-tanks, ice-house (29), and a variety of storerooms. Underneath the laboratory is a large room (32) for the stowage of natural history materials: and below the ward-room are the appropriate storerooms for the use of the mess, the navigator, and paymaster.

The poop-cabin (15), on the main deck, is a large, commodious room the entire width of the ship, and extending thirty feet forward from the stern. It contains two state-rooms, a bath-room, pantry, and office, and is conveniently furnished. The ward-room (25) underneath is thirty-eight feet long, and has eight large state-rooms, a bath-room, and pantry. It is



LONGITUDINAL SECTION OF UNITED STATES FISH-COMMISSION STEAMER ALBATROSS.

19. Reeling-engine; 20. Steerage; 21. Lower or main laboratory; 22. Boiler; 23. Coal-bunkers; 24. Engines; 25. Ward-room; 26. Cabin storeroom; 27. Magazine; 28. Magazine passage; 29. Ice-box; 30. Upper hold; 31. Lower hold; 32. Natural history storeroom; 33. Wardroom storerooms; 34. Propeller-wheel; 35. Rudder.

The forward compartment, which is raised about three feet above the general level of the house, is the pilot-house (7), containing a steam quartermaster to aid in steering. Following it in succession are the chart-room (8), upper laboratory (9), four state-rooms (10), steam drum (11), galley (12), upper engine-room (13), and entrance to the ward-room stairway (14).

Below the main deck the vessel is divided into six water-tight compartments by five transverse iron bulkheads, there being also an additional bulkhead which is not closed.

The berth-deck, forward of the collision bulkhead, is cut up into storerooms (16), reached by scuttles from the main deck. Next aft is the berth-deck proper (18), which is forty feet long and the width of the ship, with superior accommodations for a large crew. It is well lighted by a broad skylight overhead in addition to the usual side-ports. These quarters are entirely occupied by the officers of the ship, the civilian scientific staff being accommodated in the four state-rooms (10) of the deck-house abaft the upper laboratory. The latter rooms are better adapted for study than any others on the ship; each having a large, square side-window at the proper height for working with the microscope, should the naturalists desire to conduct their more delicate observations in privacy.

Of most interest to the student are the scientific quarters, which are very capacious, and amply sufficient for all possible needs. They occupy a central position, being thereby removed as far as possible from the extremes of motion caused by rolling and pitching. They extend from just above the keelson to the upper deck, and consist of three rooms on as many levels: the lowest (32) being a storeroom; the central one (21) a general laboratory, or work-room; and the upper one (9) a deck-laboratory for microscopical work and study. These rooms communicate with one another by means of stairways, but are entirely cut off from all the rest of the ship, excepting through the side-doors of the upper laboratory. The two lower rooms are protected fore and aft by water-tight iron bulkheads, reaching to the main deck; and the storeroom, which contains the supply of alcohol, can be made a tight box, and instantly filled with steam, in case of fire.

Light is admitted to the upper laboratory through a skylight, and two windows on each side, and to the general laboratory through three ports on each side, and two deck-lights overhead; but in the storeroom artificial light is necessary. During the day-time, therefore, the working-rooms are sufficiently well lighted for all ordinary purposes; but the system of electric lamps, which pervades the entire ship, reaches its height of development in these quarters, and every few feet of space contains its little glass globe and horseshoe. The effect at night is very brilliant, and work can then go on about as comfortably as in the brightest sunshine.

[*To be continued*.]

SURFACE CONDITIONS ON THE OTHER PLANETS.

IN the *Popular science monthly* for June appeared an article entitled 'Cost of life,' by John Pratt, upon the habitability of the other planets. To his conclusion that most of the larger planets are probably unsuited for habitation by beings like ourselves, I think few astronomers would take exception; but several of his statements as to their surface conditions are apparently at variance with modern observation, and with the results of the application of the principles of mechanics.

As to the light from the planets, he says, "In the first place, as might have been conjectured even before the revelations of the spectroscope, from their great volume of light as compared with their distances from the sun, all of these great bodies [the four exterior planets] are self-luminous." There is some reason to believe that at certain times portions of the surface of Jupiter do shine by their own light, but it is certainly very faint, as otherwise, when his satellites pass into his shadow, they would still reflect some light to the earth. In point of fact, however, even to the most powerful telescopes, they absolutely disappear. As to the three remaining planets, their light is so faint at the best, that any determinations as to their self-luminosity are entirely out of the question. The spectroscope shows us nothing whatever on this subject with regard to any of these bodies.

We are then told, that "the density of Jupiter being about 1.40, and that of the earth 5.48, it follows that the attraction exerted by Jupiter is roughly 300 times that of the earth. A man who weighs 150 pounds on the earth, if transported to Jupiter, would shake the ground with a ponderous tread of 45,000 pounds, or 22½ tons. His own weight would at once crush him into a mere pulp. A hickory-nut, falling from a bough, would crash through him like a minie-ball. Again: water would weigh fifteen times as much as quicksilver. A moderate wave would shiver to atoms the strongest ironclad, etc." Applying the ordinary formula, $W = \frac{M}{D^2}$, — where M, the mass of Jupiter, in terms of the earth, is 313, and D, its diameter, is 11, — we find the weight, W, of an object on the surface of Jupiter, equals $\frac{313}{121}$, or 2½ times what it would weigh here: hence our 150-pound man would weigh just 375 pounds there, and would not be seriously inconvenienced by a whole battery of hickory-nuts, provided he wore his hat. With reference to Mars, he writes, that "the relative mass of Mars being only about $\frac{1}{60}$ that of the earth [it is $\frac{1}{9}$ approximately] . . . our typical man would only weigh about 2½ pounds. . . . An 80-ton locomotive would not propel a train of empty cars. . . . A rifle-ball might be caught in the hand without harm." According to the law of gravitation, the 'typical man' would weigh 66 pounds. Supposing the 80-ton locomotive reduced in weight in the proportion he states, the cars would be so also: therefore, under any such conditions whatever, the 80-ton locomotive would draw precisely as great a quantity of matter there as it would upon the surface of the earth. As to the rifle-ball, its stored energy is proportional to MV^2; that is, it is proportional to its mass, and independent of its weight. But the mass of a body is the same throughout the universe: therefore experiments in catching rifle-balls in the hand on the surface of Mars would be dangerous.

Finally, referring to Mars, he says, "Nothing can be more certain than that there is no liquid in Mars, and no life." As seen through the telescope, the poles of Mars appear of a brilliant white color. When one of the poles is turned towards the sun, the size of the white spot diminishes, and, when it is turned away again, it increases. Some astronomers have imagined these white spots to be snow: in that case, it is difficult to account for the disappearance, unless we suppose that it melts. It therefore seems rather a strong way of expressing it to say that "nothing can be more certain than that there is no liquid in Mars." There are several other points raised by our author which would bear mentioning, one or two on the subject of energy, particularly "a large aspect of the question, which seems to have escaped the attention of thinkers;" but I think the points referred to above will be sufficient for the present occasion. W. H. PICKERING.

COMPOSITION OF THE MESODERM.

UNDER the title 'Archiblast and parablast,' Waldeyer has published a long article (*Arch. mikrosk. anat.*, xxii. 1), in which he reviews chiefly His's views concerning the origin of the connective tissue, blood-vessels, etc.; but he also considers several cognate questions.

His's investigations have been confined to vertebrates, but he apparently believes that his view is also applicable to invertebrates. Professor His distinguishes two distinct groups of tissues, — the archiblastic and parablastic. The former includes all the epithelial, muscular, and nervous tissues, comprising, therefore, the glands, smooth muscles, and neuroglia: the parablastic group comprises all the connective tissues and blood, with which are counted the blood and lymph vessels, and also the leucocytes. The parablast arises beyond the embryonic area proper as cells which grow into the embryonic region. These cells arise, according to His, out of the granules of the white yolk; these granules, from cells in the yolk; which cells are immigrated leucocytes, that enter the ovum while it is still in the follicle of the ovary.

Waldeyer accepts this division, but he differs from His mainly in two points, — first, in excluding the lining of the peritoneal cavity from the list of endothelia, and therefore also from the parablast; second, in ascribing a different origin to the parablastic cells. (As regards the first point, there can be no reasonable doubt that His's account of the origin of the membrane is erroneous: because, 1, the disappearance of the original epithelium, and the new formation by leucocytes of an epithelium on top of it, was, to the last degree, improbable, so that a gross error of observation would be more probable; 2, His was unable to bring forward any definite observations in his favor; 3, his conclusion was and has since been contradicted by the direct observations of others. Waldeyer has done good service in calling general attention to these objections, but the matter can hardly be considered new.)

As regards the second point, we reproduce Waldeyer's own summary (p. 47). In the eggs of all animals which have blood and connective tissue at all, the segmentation of the egg does not continue in the same manner up to the end; but one must distinguish a primary and a secondary segmentation: the first divides the egg, so far as it is capable of segmentation, into a number of cells which are mature for the formation of the tissue, and form the primary germinal layers. A remainder of immature segmentation-cells (in holoblastic eggs), or of egg-protoplasm, which has not assumed the cell-form (in meroblastic eggs), is left over. In either form, this remainder does not directly enter into the germ-layers as an integral component, but undergoes first a further cell-formation, — the secondary segmentation. From the cells thus formed, the parts richer in protoplasm are cut off, and make the primitive parablast-cells; while the part richer in yolk remains only to be used as nutritive material. It will be seen that the essence of Waldeyer's theory is, that a portion of the segmenting egg is retarded by the presence of yolk; and so there are some cells, or, in meroblastic eggs, some protoplasm, which is laggard in development, and does not directly enter into the primitive layers, but becomes the parablast.

The parablast is essentially identical with the mesenchyma of the brothers Hertwig, except that the latter include the smooth muscles in the group. Waldeyer endeavors to justify his theory of the origin of these tissues from laggard cells, but it seems to the reporter unsuccessfully.

There is given also, p. 38–44, a discussion of the relation of the yolk to cleavage, in which the views advanced several years ago by Minot (*Proc. Bost. soc. nat. hist.*, xix.) are brought forward anew, apparently without knowledge of their previous publication by another writer. In the discussion of the origin of the parablast-cells, p. 9–27, it appears that His's view of their origin from the white yolk is definitely shown to be untenable. Incidentally, emphasis is laid upon the fact, that, in meroblastic eggs, the protoplasm of the animal pole sends down processes into the yolk: it is from these processes in the 'keimwall' of birds' eggs that the parablast-cells arise, according to Waldeyer. His article, as a whole, is chiefly a discussion of the literature of his subject. C. S. MINOT.

THE ECLIPSE OF 1882.

AT the present time, when interest is chiefly drawn toward the successes of the astronomers who observed the eclipse of the sun month before last from the small islands in the Pacific Ocean, the results of the eclipse of May 17, 1882, obtained in Egypt, have especial significance. These were briefly stated by Dr. Schuster at a late meeting of the Royal astronomical society. During the progress of the eclipse three photographic instruments were at work: one took photographs of the corona itself; a second was a photographic camera with a prism placed in front of it, that is, a spectroscope without a collimator; and the third was a complete spectroscope. Photographs were obtained in all three instruments. The direct photographs of the corona indicate its variations from eclipse to eclipse, — a matter of much importance in solar physics. If the photographs taken during eclipses in the past twenty years are compared with each other, it will be seen that the corona varies in a regular way with the state of the sun's surface, although there are irregular minor changes. At the sun-spot minimum the corona is much more regular than at the maximum. At the minimum there is a large equatorial extension, and near the solar poles a series of curved rays. At the maximum there is practically no regularity at all: the long streamers go up sometimes in one direction, and sometimes in another; and this last year, near the sun-spot maximum, there was absolutely no symmetry in the appearance of the corona. The transparency of the streamers was most striking. One streamer can sometimes be traced through another, showing that the matter, whatever it is, must be very thin. The rifts start from the solar surface in an entirely irregular way, with a tendency very often toward the tangential direction at the lower parts of the rifts. The photographs extend about a diameter and a half from the sun's limb, and a comet appears on the plates about a solar diameter and a half from the sun's centre. It must have been very bright, as it appears clearly in the photographs. Measurements seem to indicate a small shift in its position during the interval between the first photograph and the last.

Turning now to the photographs taken with the camera and prism in front, — an instrument which gives an image of the prominences as oft repeated as there are rays in the prominence, — the plates employed were sensible to the infra-red as well as violet rays. One prominence gave a great number of lines in the ultra-violet. The fact was brought out in this eclipse, that the brightest lines in the prominences are due, not to hydrogen, but to calcium. Besides these and the hydrogen lines, there is the line D_3 in the yellow, and the C line of hydrogen in the red, and also a photograph of two prominence-lines in the ultra-red. In addition to the prominences, there are visible in the photographs certain short rings round the moon, which mean that at these places the light sent out by the gaseous part surrounding the moon is not confined to the prominences. It is, as would be expected, the green coronal line which chiefly corresponds to one of those rings. This green line, K 1474, is a true coronal line, and is only very faintly traceable in one of the prominences.

In considering the results obtained with the complete spectroscope, it is a striking fact that some of the lines cross the moon's disk, and especially the two lines H and K. This proves that the calcium-lines, H and K, were so strong in the prominences that the light was scattered in our atmosphere, and reflected right in front of the moon.

The prominence-lines are very numerous: thirty such lines appear in the photograph. The hydrogen-lines are there, including those in the ultra-violet photographed by Dr. Huggins; also H and K, and other calcium-lines; and still others, chiefly unknown.

Close to the sun's limb we can only trace a continuous spectrum, a very strong one, going up to about a quarter of a solar diameter. The photographs bear out the distinction between the inner and the outer corona, the former being much stronger in light. The boundary at which this continuous spectrum ends corresponds to the extension of the inner corona. The continuous spectrum is stronger on the side where the prominences are weaker. In the corona we first of all see a very faint continuous spectrum, and in that continuous spectrum one can trace at G the reversal of the dark Fraunhofer lines. In addition, a series of faint true coronal lines can be traced in the outer regions of the corona. We have not traced any known substances in the solar corona. The greater number of the prominence-lines in the ultra-violet are also unknown, but they seem to be present in Dr. Huggins's photograph of the spectrum of α Aquilae.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

The relative ages of planets, comets, and meteors.

The theory that the sun was once a gaseous mass extending beyond the most distant planet, and that it has contracted to its present dimensions by the continuous action of gravity, and is still so contracting, is now very generally accepted by astronomers. It is well known, moreover, that the condensation of a gaseous body produces heat, and that the impact of solar matter in consequence of its motion towards the centre of gravity is one cause, at least, — perhaps the principal one, — of the sun's high temperature. The modern law of the conservation of energy affords data for determining the amount of heat produced by the condensation of the sun's mass from one volume to another. It is thus found that the contraction to its present dimensions, from a primitive volume extending indefinitely beyond the orbit of Neptune, would have kept up a uniform supply of heat equal to the present for twenty millions of years.[1] The age of the solar system, however, may be greater or less than this, as the sun's radiation may not have been constant.

In any form of the nebular hypothesis, Neptune is the oldest planet known, and the innermost of the number has had the most recent origin.

A majority of comets probably move in hyperbolas, and visit the solar system but once. Some orbits have been changed into ellipses by planetary perturbation.

For any thing we can know to the contrary, cometary matter has been falling towards the centre of our system in all ages of its existence. Whenever the perihelion distance has been less than the radius of the solar spheroid, the comet's orbital motion must have been arrested, and transformed into heat.

As the limits of geological dates are determined by the strata of the earth's crust, so the superior limits of the age of periodic comets are fixed by the planetary orbits next exterior to their perihelia. Of the comets known to be periodic, the perihelion distances of thirteen are less than the earth's distance from the sun. The ages of all these must therefore be less than that of the earth. In like manner the ages of others are shown to be less than that of Venus, while those of a few are found to be less than the age of Mercury. We may conclude, then, in general, that the ages of comets, as members of the solar system, are less than those of planets.

But as meteoroids, partly at least, are derived from comets, their origin as separate bodies in connection with our system must be still more recent: in fact, meteoric matter is being constantly detached from comets at each successive return to perihelion. The indications of this process were unmistakable in the case of the great comet of 1882, and many meteoroids of the Biela group have been separated from the comet in our own day. Daniel Kirkwood.

Bloomington, Ind.

First use of wire in sounding.

Professor Verrill is quite right in supposing that I was unaware that any report of the sounding expedition of Walsh had been published. A casual reference to Walsh in the 'Depths of the sea' led me to inquire,

[1] A contraction of the radius equal to a hundred and twenty-nine feet per annum would yield the present supply of heat. See Monthly notices of the R. A. S., April, 1872.

through a naval friend, of an officer in the Navy department, unofficially, whether any report had been published. This gentleman was kind enough to make inquiries, and finally replied that he could not find out that any thing had been printed, but that the log-books were at the department On this account I made no further search for printed data; but later, on Commander Bartlett's installation at the Hydrographic office, I mentioned it to him, and he had the goodness to search the log-books, and to send me copies of *all* references to the work with wire, contained in them, from which my note was compiled. Doubtless other note-books might have been used also. In regard to the breaking of the wire, it is specifically stated in the log-book that it parted 'owing to some of the links catching at times on others,' as the line was *paid out* in one or two cases, and in others as it was being hauled in. In another instance it parted 'owing to one of the joints catching upon another joint on the reel.' It is nowhere in the *original log* referred to the heaving of the vessel; and the last entry repeats, 'entirely owing to the short nip of the catch upon the reel.' Having had some experience in sounding in great depths of water with a small sailing-vessel, I have come to the opinion, in which I think most practised hydrographers would concur, that it is impossible that a plumb sound should be obtained from such a vessel under any circumstances likely to occur in actual work. The words quoted by Professor Verrill from Walsh's report show that the latter officer deceived himself; for it is evident, that, if the wire 'served as an anchor to keep the vessel steady,' it could not have been plumb; and, even if it appeared to be so at the surface, what it was below the surface no man could state with confidence, except that it was *not* plumb. A steamer may be kept over the wire, and, with wire properly spliced and heavily weighted, a plumb sound can be had, but not otherwise; and it may be confidently said that *accurate* sounding in deep water dates from the combination of these two factors. I may say, also, that in my note I did not, nor do I now, consider that successful trial of a sounding apparatus has been arrived at, until bottom has been reached, and the signs of it brought up. WM. H. DALL.

Washington, June 23, 1883.

False claims.

It is to be regretted that the pages of a popular magazine of high standing should be made the vehicle of such an advertisement as appears in the *Century* for July, entitled 'Cheap food for the million,' reprinted in the publisher's department of SCIENCE for June 22. Of the merits or demerits of a new food-preservative, of which so many have been brought forward within the last few years, I have nothing to say: the testimony of Prof. S. W. Johnson, cited in its favor, is certainly entitled to respectful consideration. But I wish to call attention to the claim of the inventor of the new nostrum to public confidence on the ground that he is "a fellow of the Chemical society of London, and also of the Geological society, being elected after unusually severe examinations. President Huxley, of the latter society, said that 'no American should boast of an election without a severe struggle.' In evidence of this prejudice towards Americans, the fact that Professor Humiston was given two hundred and fifty questions (five times the usual number) may be cited. He is now superintendent of the company's works," etc.

It is not clear what meaning is to be attached to the words put into Huxley's mouth; but it is a well-known fact that neither in the societies named, nor any others with which I am acquainted, is there any examination whatever required, or are any questions asked. A nomination by three members, one of whom must have personal knowledge of the candidate, and the payment of fees, are the only conditions necessary to membership of the Geological society of London, which has several hundred members upon its lists, including many Americans. In the complete catalogue of all scientific papers published in Europe and America up to 1877 (*Roy. soc. cat.*) we search in vain for the name of the 'superintendent of the company's works.' It is not creditable to the advertisers that the names of illustrious men of science and of learned societies, coupled with erroneous statements and absurd appeals to national prejudices, should be invoked, even indirectly, to recommend their wares. T. STERRY HUNT.

Montreal, June 25, 1883.

MACLOSKIE'S ELEMENTARY BOTANY.

Elementary botany, with students' guide to the examination and description of plants. By GEORGE MACLOSKIE, D Sc , LL D., professor of natural history in the J. G. Green school of science, Princeton, N J., etc. New York, *Holt*, 1883. 370 p. 12°.

SCIENCE is ready to welcome a new text-book, asking only for some particular line of excellence as a warrant of its reason to be. Considering that "this volume aims to supply a readable sketch of botany," and so to treat the subject "as to meet the wants of a large class of readers who wish to know something of the fundamental principles and philosophical bearings of the science without being distracted by technicalities," we think that its readable character and the comparatively sparing use of unnecessary technical terms are among its commendable features. The style is easy, sometimes a little odd in its concatenations, as where "it is said that a monkey first introduced tea to the notice of the Chinese; the English government started its cultivation in Assam, whence the best teas now come;" and in the following paragraph it becomes even sensational.

"Their power of increasing in thickness imparts to roots their capacity for mischief. Their vigor is somewhat surprising. They make their way through dense soil, loosening it so that it becomes soft and spongy. They can split rocks, overturn walls and buildings, stop up sewers, and root up our street-pavements. They effect more injury to man's handiwork than tempest, fire, and war combined. . . . We possess a root hugging an old bottle in irredeemable captivity."

In a well-known passage at the close of one of his books, Darwin likened the tip of a root to the brain of one of the lower animals; and brains, we know, are capable of mischief, and therefore of demoralization. Whether the root which the author is so fortunate as to possess is in dipsomaniac captivity to the bottle it hugs, or whether the bottle is captivated by the caressing root, is not quite clear from the context. And how such dire mischief to man wrought by roots — more injurious 'than tempest, fire, and war combined' — is to be reconciled with creative benevolence, we must leave for the Princeton theologians to settle, and pass on to another topic, that of judicious abstinence from technicalities.

Writers of text-books are prone to employ all the technical terms they can find, especially new-fangled ones which have not yet proved their right or reason to exist by continued usage, or which, though convenient in an original treatise or memoir, and harmless or even useful in a glossary, may be advantageously dispensed with in ordinary scientific teaching. We all know of the painter commemorated by *Punch*, who 'rubbed out a good deal,' and who claimed to 'get his best effects that way.' Many scientific books for students' use might be bettered by the same process. Professor Macloskie has so well resisted the ordinary temptation, or restrained in parenthesis needless terms which he did not like to leave out, — such as *xylem*, Greek for wood, most barbarously Germanized (as if, where a Greek said *xylon* and a Roman said *lignum*, we might not say *wood* when we meant it), — that it may be a little ungracious to complain of his making one or two himself, and making them badly. Where he says, "to avoid confusion, we shall call [the seed-coats] *exotest* and *endotest*," the inference is, that these terms are original. Nor, not to insist that confusion is rather made than avoided by the substitution of new names for well-recognized old ones, we might suggest that the coinage is in a small way pedantic, except that a pedant would not violate what our author in another place terms 'the jus connubii' by hybridizing Greek with Latin. Nor, if we must have such Greek-Latin crosses, would he have truncated them into *quasi* English, which is as bad as a third cross, but have written *exotesta* and *endotesta* in full, vile as the terms are. *Gametic* is certainly new coinage; and the author does not clearly say what he means it to pass for. But it may be gathered that 'gametic affinity' means relationship near enough to allow of interbreeding. We are to say, then, that species belonging to different genera have gametic affinity in the rare cases when they can be made to hybridize; and that certain species strictly of the same genus, which we have failed to hybridize, are devoid of gametic affinity: so the term has no explanatory value whatever.

Some of the borrowed woodcuts are very good; most of the original ones are quite the reverse; and the one which is said to represent a 'tip shoot of pea' is a complete puzzle, after all the enlightenment which the letterpress affords.

Turning over the pages, we now and then come upon statements which dampen any enthusiasm of commendation which a reviewer might wish to express. On p. 16 we read that "cymose flowers are always actinomorphic, being equally exposed to light in all directions." The implication that 'actinomorphic,' i.e., regular, flowers are so because equally exposed to light from all directions is a bit of deductive botany of the Grant Allen school. And the assertion that cymose inflorescence and actinomorphic flowers always go together is by no means true, as witness all Labiatae and a large share of other didynamous flowers. The seed "in Lepidium, on being moistened, darts out mucilaginous threads." Is Dr. Macloskie sure of this, or does he infer that there must be such threads because they exist in various other seeds and seed-like fruits which develop mucilage when wetted? The hypocotyledonary stem "in the pea is short because the seed remains underground." Were it not better to say that the seed remains underground because this initial stem does not lengthen? On p. 82 it is asserted, or at least implied, that root-hairs last all summer long, and may be renewed on a surface that has lost them. To Grant Allen, in the year 1882, is attributed the idea that neutral ray-flowers of Compositae are sterilized members set apart and enlarged for purposes of display. Has Dr. Macloskie met with no earlier exposition of that doctrine?

Not to prolong questioning, let us say, that, for those who are most likely to use this book, it was a good idea to devote a few pages at the close to the derivation of common terms, Latin and Greek root-words, and prefixes, and to help those who do not know the Greek alphabet by writing out the words, as nearly as may be, in Roman letters.

THE GEOLOGY OF BELGIUM.

Géologie de la Belgique. Par Michel Mourlon. 2 vols. Bruxelles, *Hayez*, 1880-81. 317; 16+392 p., illustr. 8°.

This book, a model in its way, will be read with equal profit by the geologist and by the general reader. The geologist will find in it, critically exposed, and in a short and impartial manner, the immense amount of labor and of detail which is scattered in the numerous papers of the Belgian geologists. Any one of ordinary intellectual culture, and interested in Belgium, will find it a clear and readable account of the past history and chief features of the country. Two causes have contributed to make easier the task of the author: the works on the geology of Belgium by d'Omalius, Dewalque, and especially the celebrated 'Esquisses géologiques' of Gosselet, have already pointed out the way to success; and, moreover, the natural disposition of the country allows a very simple grouping of facts.

Both geologically and geographically, Belgium is formed of two distinct parts. The southern half (the Ardennes) is a hilly region, a continuation of the old paleozoic nucleus of Europe, — the so-called Hercynian mountain-range; the northern half (Flandres, etc.) is a flat land or prairie region, and forms part of the great plain of northern Europe, the basin of the North Sea. The Ardennes is a paleozoic district; Flandres, a tertiary one; the triassic, Jurassic, and cretaceous formations forming but a broken belt around the paleozoic masses. All these formations are, however, studied by the author in a complete manner, and their mineralogical, paleontological, and stratigraphical characters successively described. Both their historical divisions and their local extension are given with care.

Beginning with the older rocks, we first meet the Cambrian shales, forming two principal ranges (massifs de Rocroy and de Stavelot). These rocks can be compared to the Ocoe conglomerates and shales of the Appalachian region; they contain the curious interbedded crystalline porphyroids, so well illustrated by de la Vallée Poussin and Renard, whose papers are here summarized in two good plates. The Silurian beds form two small crests extending east and west, through Brabant and Condros, and have supplied fossils of Barrande's second fauna. These beds, like the underlying Cambrian, have a southerly dip. The upper Silurian fauna is not represented.

The folding of the Silurian rocks was the initial cause of the so-called Dinant and Namur devono-carboniferous depressions, or basins. It was followed by a long-continued depression of the area, in consequence of which the accumulation of an enormous thickness of stratified rocks within the great troughs of Dinant and of Namur took place. This downward bending of the earth's crust did not go on continuously, but submitted to some irregularities related to the breaks and numerous stratigraphical divisions of the Devonian formation. The Devonian formation of Ardennes is the most complete and best studied in Europe, through the labors of Dumont, Gosselet, Dupont, and the author. It shows a thick series of four thousand metres of alternating fossiliferous shales, sandstones, and limestones, marine for the chief part, though some beds have furnished Psilophyton and other plant-remains. After the period of the mountain limestone, littoral, brackish water, and finally lacustrine and terrestrial deposits, came in, and the coal continued forming.

A general movement of elevation succeeded towards the end of the coal-measures, and folded all the paleozoic sediments as if they had been crushed from south to north. This thrust had a more violent effect in the Namur than in the Dinant basin. In the former are comprised the celebrated coal-fields of Mons, Liége, and Charleroy, — the chief causes of Belgian prosperity and wealth.

At the close of the paleozoic period, the mountainous region of southern Belgium was formed; and since then it has always been exposed to denudation. South of this mountainous district, the Jura-triassic beds of eastern France now began to accumulate in the Gulf of Luxemburg (Buntersandstein and Keuper, and the Jurassic from the Avicula contorta beds to the middle oölites). These mesozoic seas did not penetrate north of the Ardennes, where the lower cretaceous are the most ancient mesozoic formations.

The cretaceous formations in this district possess great interest, notwithstanding their small geographical extent. The lower beds have furnished the splendid iguanodons of the Brussels museum, and the upper ones are the well-known Maestricht beds. All are chiefly littoral formations; and the so-called tourtias of the middle cretaceous are famous by the variety and richness of their faunas. In the deep and narrow Gulf of Mons, the cretaceous beds are found in a chalky condition, as in the Anglo-French basins.

In the neighborhood of Mons and Landen are found the most ancient representatives known in Europe of the tertiary epoch (systèmes montien, heersien), so well illustrated by Cornet and Briart. The Landenian system has a wider extension, forming, with the other terms of the eocene series, nearly all of lower Belgium. Thus it is to the wide-spread mass of the London clay, which covers the Landenian sands, that Belgium owes its meadows and well-cultivated fields, which extend in an immense plain from the Brabant to the coast.

and from Dunkirk to Ostend. The Bruxellian and Laekenian systems form superficial hills in the neighborhood of Brussels, Gand, etc. The oligocene system shows two principal divisions (tongrian, rupelian), which stretch across the lower part of the river Escaut, where it leaves the eocene districts, through which it flows in the western part of the country. The pliocene formations overlap irregularly the underlying tertiary beds, and extend from Antwerp to Louvain. Many fine fossils have been found in these beds, where Mourlon admits several divisions, — Diestien (in part), Anversien, and Scaldisien. The last chapters of the work treat of the quaternary (diluvien, hesbayen, and campinien) and recent periods.

Though special attention has here been given to the stratigraphical extent and disposition of the beds, the author has treated with equal care of their lithological and paleontological characters, their minerals and fossils, and the useful products they furnish to Belgian industry. It will be enough, to indicate what amount of documents are included in the book, to state that the lists of fossils occupy 240, and the bibliographical lists 144 pages.

DU MONCEL'S ELECTRO-MAGNETS.

Electro-magnets. The determination of the elements of their construction. By TH. DU MONCEL. From the second French edition. New York, *Van Nostrand*, 1883.

The same. Translated from the French by C. J. Wharton. London, *Spon*, 1883.

THE great interest in the practical applications of electricity demands simple treatises on the most economical methods of making electro-magnets. Count Th. Du Moncel has endeavored to supply this want, and has added another treatise to the long list he has already published upon electricity. He disclaims any endeavor to make a treatise on electro-magnets which shall embody scientific theories upon that most difficult of subjects, theoretical magnetism. His desire is to give the mechanician a *vade mecum* by means of which he can construct electro-magnets for operations outside the laboratory. Indeed, this treatise is intended to stand in the same relation to the maker of dynamo-electric machines as a treatise on the practical construction of boilers, minus theories of elasticity, would stand to the constructor of steam-engines. There is need for such a treatise, undoubtedly; for much expense can be saved by a little knowledge where to put the material to the best advantage. Most of the dynamo machines which are before the world at the present time are defective in the arrangement of the wire of the field electro-magnets. Does the treatise of Du Moncel supply this want? The author follows the antiquated French fashion of expressing the resistance of a wire in terms of the length and diameter, without specifying, in many cases, the specific resistance. Thus, instead of ohms, we read so many metres of telegraph-wire; and one must enter into a troublesome arithmetical drudgery to ascertain what is meant. The English edition, published by Spon, states in the preface the relation between Du Moncel's units and the commonly received units of resistance and electro-motive force; but the American edition, published by Van Nostrand, leaves the reader to find out this relation after he has plodded some distance through the treatise.

The two imprints, one by Spon and the other by Van Nostrand, are carelessly edited. Thus, on p. 43 in Van Nostrand, we find an inconsistency between the values of t^2 and A.

On p. 47, Van Nostrand gives

$$ab = \frac{\rho}{e^2}\,0.000506\,\sqrt[3]{\sqrt[3]{P^4f^8}}$$

$$= \frac{\rho}{e^2}\left(0.0225\,\sqrt[3]{\sqrt[3]{P^2f^4}}\right)^2;$$

while Spon gives, on p. 34,

$$ab = \frac{\rho}{e^2}\left(.0225\,\sqrt[3]{\sqrt{P^2f^4}}\right)^2$$

$$= \frac{\rho}{e^2}\,.000506\,\sqrt[3]{\sqrt[3]{P^4f^8}}.$$

We give this as an example of similar mistakes which meet the eye. The question arises whether a more carefully prepared treatise, which would start with the fundamental system of electrical measurements, is not still needed. It is useless for any one to endeavor to become a practical electrician to-day, without a sound training in mathematics as far as the principles of the differential and integral calculus. A genius may arise, but he will know enough to employ a steady plodder who has been steeped in the principles of the calculus. Most constructors who desire to build electro-magnets will find that the exigences of space and material will demand a certain form. Unless they understand the theory of magnetic measurements, they will find the treatise of Du Moncel of little value; for so many and so large approximations must be made, that the final result would not differ much from those obtained by a thumb-rule. We commend to the practical electrician a study of the fundamental magnetic measurements rather than the perusal of treatises of this nature.

LEDGER'S SUN AND ITS PLANETS.

The sun, its planets, and their satellites. By Rev. Edmund Ledger, M.A. London, *Stanford*, 1882. 432 p. 12°.

Of late a considerable number of semi-popular works have appeared on astronomical subjects. They seem to meet a felt want of the community, and have been very successful. We call them *semi*-popular: because, while they are not written for professional astronomers, they are adapted, in their style and mode of treatment, less to the great masses of the business and laboring population than to the educated people who are engaged in various professional occupations. Those, for instance, who are busy in teaching, or with the practice of medicine or law, or who are pursuing geological or biological research (in short, pretty much all who would naturally subscribe for Science), generally wish to keep *au courant* of what is going on in other than their own special lines of work, and are delighted to find what they want, when they can get it in an attractive form.

Mr. Ledger's book is an excellent one of this class. It is less diffuse than Mr. Proctor's essays, and not quite so imaginative. It is narrower in its scope than Professor Newcomb's Popular astronomy, but easier reading, and fuller of detail in respect to the subjects of which it does treat. It makes no special claims to originality, but is accurate and clear, and the style is unpretentious and agreeable. The book is nicely gotten up, and very well illustrated. Altogether, we have no hesitation in pronouncing it a volume well worth reading and possessing.

It is made up of fifteen lectures read in 1881 and 1882 in Gresham college, London. Two are upon the sun, two are devoted to the moon, two to the earth, and two to Jupiter and his satellites. Each of the other planets has a chapter to itself (counting the group of planetoids as one), and there is a chapter entitled 'Ptolemy *versus* Copernicus.' Naturally, the lectures are not all of equal interest and value; but none of them are poor, or could be well dispensed with. The chapters upon Mars and the planetoids strike us as particularly good, and contain information not otherwise very easily accessible. The chapters on the sun and moon are also excellent, though naturally enough, in the main, only an abridgment and compilation from the recent books on these subjects; to which books the author handsomely acknowledges his obligations.

There are remarkably few mistakes in the work: in fact, in reading it over for this notice, we have found none at all, unless we count as such, a blunder in the illustration on p. 147, representing the comparative size of the sun as seen from Mercury at perihelion and aphelion; the difference being represented very much greater than the truth. Speaking of illustrations, the fine Woodbury-type of the eclipse of 1871 deserves special mention, and several of the pictures of Mars and Jupiter are unusually excellent. It is rather a pity that a few pages of tables were not appended, containing the numerical statistics of the planetary system. They would have greatly increased the value of the book for those who wish not merely to read it once, but to keep it on their shelves for occasional reference.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Flexure of the broken transit.—Professor C. A. Young, after alluding to the fact that the flexure-correction of this peculiar form of transit is not treated of in any of the common text-books on practical astronomy (not even in Sawitsch, who specially describes and discusses the instrument itself), states the theory of the correction to transits of stars observed with the 'broken transit,' which is often so great as to amount to a large fraction of a second of time at the zenith. The constant of flexure must be known, and its effect eliminated, before the collimation error can be determined by reversal of the instrument on a circumpolar star. The correction has the same coefficient with the level-error; and denoting this latter, as usually obtained, by b, the flexure-constant by f, and the pivot-correction by p, the complete formula for the 'level-constant' is $[b \pm (f \pm p)]$. Thus, by flexure, the time of transit of a star is affected by $f \cos z \sec d$. The sign of f changes with the reversal of the instrument, being always plus for eye east, and minus for eye west. Prof. Young gives several methods of determining f: by observing zenith stars in reversed positions of the instrument, by means of the collimating eye-piece and mercury-basin, or a vertical collimator supported above the instrument, and by least-square treatment of equations given by repeated observation of suitable stars in both positions of the instrument. Some forms of the 'broken telescope' transit, especially those with a slender axis, require the addition of terms involving other functions of z than its cosine. Prof. Watson found for a Stackpole transit a flexure-correction of the form $(f \cos z + f' \cos^2 z) \sec d$. But if the axis is reasonably stiff, the second term is never sensible. — (*Sid. mess.*, June.) D. P. T. [1

MATHEMATICS.

Double theta-functions. — M. Caspary gives an account of some of the more elementary theorems concerning the theta-functions of two variables. He proves first, in a very simple manner, that the squared functions can be arranged in the form of a determinant of the fourth order which satisfies all the conditions of a determinant of an orthogonal substitution. He derives also the Göpel relations between these functions and their application to Kummer's surface. A number of other fundamental theorems are also arrived at in a very elementary manner, making the paper a valuable introduction to the study of the double theta-functions. — (*Journ. reine ang. math.*, xciv. no. 1.) T. C. [2

Periodic functions. — M. Hurwitz discusses single-valued $2n$-fold periodic functions which throughout a finite region have the character of rational functions, and which are real for real values of their arguments. More exactly he examines the properties of the periods of such Abelian integrals as belong to a real algebraic form (*gebilde*). By a *real* algebraic form he means the aggregate of all pairs of values of (x, y) which satisfy an irreducible algebraic equation $(F(x, y) = 0)$ whose coefficients are all real. Defining a periodic function by the equation

$$\phi(u_1 + P_1, u_2 + P_2 \ldots u_n + P_n) = \phi(u_1, u_2 \ldots u_n),$$

the complex of quantities P_a is called a period of the function ϕ, a single one of these quantities being called a modulus of periodicity. A period is then real or pure imaginary when the moduli of periodicity which constitute it are real or pure imaginary. The principal theorem arrived at by the author is as follows: let $\phi(u_1, u_2 \ldots u_n)$ denote a single-valued $2n$-fold periodic function which everywhere throughout a finite region possesses the character of a rational function, and which takes real values whenever its arguments are real; then there are always n period-pairs,

$$(P_{1\beta}, P_{2\beta} \ldots P_{n\beta}), (P_{1, n+\beta}, P_{2, n+\beta} \ldots P_{n, n+\beta}),$$

which form together a system of primitive periods of the function, and which are of such a nature, that, for each pair, one of the two conditions following is satisfied: either the first period $(P_{1\beta} \ldots P_{n\beta})$ is real, and the second period $(P_{1, n+\beta} \ldots P_{n, n+\beta})$ is purely imaginary; or the first period is real, and the period $(2P_{1, n+\beta} - P_{1,\beta} \ldots 2P_{n, n+\beta} - P_{n\beta})$ is purely imaginary. — (*Journ. reine ang. math.*, xciv. no. 1.) T. C. [3

PHYSICS.

Liquefaction of nitrogen and carbonic oxide. — S. Wroblewsky and K. Olszewski give a more detailed account of the liquefaction of nitrogen (SCIENCE, i. 970). The gas remained invisible when submitted to a pressure of one hundred and fifty atmospheres and a temperature of $-136°$; but, when the pressure was slowly reduced to fifty atmospheres, the gas was liquefied, presenting a visible meniscus, and evaporating very rapidly. Under the same conditions, the authors succeeded in liquefying carbonic oxide, which formed a colorless liquid with a visible meniscus. — (*Comptes rendus*, xcvi. 1225.) C. F. M. [4

Optics.

Mirage. — In an article entitled "State of the atmosphere which produces the forms of mirage observed by Vince and by Scoresby," Prof. Tait presents some very interesting researches regarding these particular forms of mirage. After an historical note, in which he refers to two valuable contributions to the subject by Wallaston and by Biot, which go far toward a solution of the problem, but have unfortunately fallen into oblivion, he presents his own investigations. His method consists in treating the curvature of a ray of light in the same way as the motion of a projectile; the two cases corresponding when, in the case of mirage, the square of the index of refraction of the air is proportional to the distance from a given horizontal plane.

He finds, however, that, "whatever be the law of refractive index of the air (provided it be the same at the same elevation), all we have to do to find the various possible images of an object at the same level as the eye is to *draw the curve of vertices for all rays passing through the eye in the vertical plane containing the eye and the object, and find its intersection with the vertical line midway between the eye and the object.*" By making suitable suppositions regarding the change of density, he finds that "the conditions requisite for the production of Vince's phenomenon are a stratum in which the refractive index diminishes upwards to a nearly stationary state, and below it a stratum in which the upward diminution is either less, or vanishes altogether." It will be seen that the solution of the problem of atmospheric density and refraction by this means is entirely indeterminate. The supposition of Prof. Tait satisfies the conditions presented by the observations of Vince; but that it is the only law or the true law must be verified by investigations of a different nature.

The method is especially valuable in its inverse form as affording a test of supposed laws of density and refraction in their ability to furnish the various phenomena of mirage. — (*Nature*, May 24.) G. E. C. [5

(*Photography.*)

Concentrated developer in one solution. — Where the photographer intends to travel, and develope on the route, it is very desirable to reduce his chemical outfit to the smallest bulk and to the fewest liquids possible. Mr. G. Cramer, the dry-plate manufacturer, gives the following formula for a developer, which he considers gives the best of results, and at the same time has the advantage of extreme portability.

Stock solution.

Sulphite of soda (crystals)	3 ounces.
Bromide of ammonium	½ ounce.

Bromide of potassium	1½ ounces.
Pyrogallic acid	2 ounces.
Dissolve in distilled water	32 ounces.
Add sulphuric acid (c. p.)	120 minims.
Add aqua ammonia (strongest) . . .	3 ounces.
Add water to make up bulk to . . .	40 ounces.

The sulphuric acid and aqua ammonia should be measured very exactly. Instead of three ounces of crystals, two ounces of granular sulphite of soda may be substituted to produce the same effect. Dilute a sufficient quantity for one day's use as follows: for ordinary purposes, one part in eleven; for very short exposures, one part in three to six; for over-exposed plates, or in all cases where great intensity and contrast are desirable, one part in twenty. This developer may be used repeatedly if it is always returned immediately to the pouring-bottle, which should be provided with a tight-fitting rubber stopper. As long as the solution remains transparent, it is good; but when it looks muddy its use should be discontinued. — (*Philad. phot.*, June.) W. H. P. [6

ENGINEERING.

Mill-engines. — The Southwark iron foundry has constructed for Messrs. Cheney Brothers of South Manchester, Conn., a compound 'Porter-Allen' engine, having steam-cylinders 12 and 21 inches diameter, 2-feet stroke, to run at 180 revolutions per minute. The power is given at 200 horse-power. The ratio of expansion is 16. The expenditure of water was 18.5 pounds per horse-power and per hour. Of this, 11.75 was accounted for by the indicator: the rest was wasted by condensation in the steam-cylinders and by leakage. In these engines the low-pressure cylinder is steam-jacketed, and the exhaust from the high-pressure cylinder passes into an intermediate reservoir, from which the large cylinder is supplied. The reservoir acts as a separator for the water carried in with the steam; and this water is trapped off, and does not reach the low-pressure cylinder. — (*Mechanics*, May 19.) R. H. T. [7

Compressed steel. — Tests have been made at the Watertown arsenal on cold-worked steel made by Naylor & Co. at the Norway steel and iron works, Boston, Mass. The elastic limit is raised from 26,540 pounds per square inch (1,966 kgs. per sq. cm.), in the hot-rolled bar, to 61,000 pounds (4,288 kgs.) in the cold-rolled steel. The ultimate strength is increased from 55,400 pounds (3,895 kgs.) to 70,420 (5,140 kgs.), in one case, and to 81,890 (5,757 kgs.) in another. The results of tests made at the mechanical laboratory of the department of engineering of the Stevens institute of technology are given, showing the increase due to cold rolling to be 70 per cent of the original torsional strength with iron, and over 150 per cent with soft steel. The resilience, or shock-resisting power, was increased, in an average of three tests, nearly 300 per cent in iron, and to double the latter quantity in steel. — (*Ibid.*) R. H. T. [8

Time-fuze for artillery. — Col. Richardson, R.A., finds that all the forms of time-fuzes at present in use are unsatisfactory, since they depend for their accuracy on the length of time during which a given column of composition burns: and this is a matter which is difficult of control at the best. He proposes to take advantage of the rapid and regular rotation of the shell during its flight by which to work a mechanism, which shall liberate a concussion-fuze at any desired moment. — (*Proc. roy. artill. inst.*, April, 1883.) C. E. M. [9

CHEMISTRY.

(General, physical, and inorganic.)

Basic sulphates of copper. — By continued boiling of a solution of cupric sulphate, S. U. Pickering obtained a basic sulphate, to which he assigns the formula $6\,CuO \cdot 2\,SO_3 \cdot 5\,H_2O$. Precipitation in the cold with potassic hydrate gave the basic salt $4\,CuO \cdot SO_3$. — (*Chem. news*, xlvii. 181.) C. F. M. [10

The hydrates of chlorine. — E. Maumenè thinks that the hydrate $Cl \cdot 10\,H_2O$, mentioned by Faraday, does not exist. Maumenè observed the formation of the hydrate $Cl \cdot 4\,H_2O$, which crystallized in cubes, and of the hydrate $Cl \cdot 7\,H_2O$ in well-marked crystals. With an excess of water, the hydrate $Cl \cdot 4\,H_2O$ is converted into the form $Cl \cdot 12\,H_2O$, which forms orthorhombic crystals. — (*Bull. soc. chim.*, xxxix. 397.) C. F. M. [11

Ammoniacal bromides and oxy-bromides of zinc. — When zinc oxide is dissolved with the aid of heat in a solution of ammonic bromide, G. André states that the compound $3\,ZnBr_2 \cdot 3\,NH_3 \cdot H_2O$ is formed. This compound is completely decomposed when boiled with a large quantity of water, leaving only the oxide. The compound $3\,ZnBr_2 \cdot 4\,NH_3 \cdot H_2O$ is formed when the experiment is conducted in the cold. On passing dry ammonia gas into a solution of zinc bromide, it is absorbed, with the formation of the product $3\,ZnBr_2 \cdot 5\,NH_3 \cdot H_2O$. The compound $2\,ZnBr_2 \cdot 5\,NH_3$ results when the ammoniacal bromide $2\,ZnBr_2 \cdot 5\,NH_3 \cdot 2\,H_2O$ is heated. The following oxy-bromides were prepared by methods similar to those which give the oxy-chlorides: $ZnBr_2 \cdot 4\,ZnO \cdot 13\,H_2O$, $ZnBr_2 \cdot 4\,ZnO \cdot 19\,H_2O$, $ZnBr_2 \cdot 5\,ZnO \cdot 6\,H_2O$, $ZnBr_2 \cdot 6\,ZnO \cdot 35\,H_2O$. — (*Bull. soc. chim.*, xxxix. 398.) C. F. M. [12

Artificial hausmannite. — By heating manganous chloride to the point of fusion for several hours, A. Gorgeu obtained crystals, on cooling, which possessed all the properties of the mineral hausmannite. — (*Comptes rendus*, xcvi. 1144.) C. F. M. [13

Formation of sulphides by pressure. — W. Spring submitted finely divided magnesium with the amount of sulphur calculated for one atom to a pressure of sixty-five hundred atmospheres. The product proved to be a homogeneous mass which gave off hydric sulphide when heated with water to 50° or 60°. Zinc sulphide was formed by subjecting a mixture of zinc and sulphur to the same pressure. Iron united with sulphur, forming, probably, a polysulphide. Cadmium gave a yellow powder, from which hydrochloric acid liberated hydric sulphide. Sulphides of aluminum, bismuth, lead, silver, copper, tin, and antimony were obtained by this process. — (*Berichte deutsch. chem. gesellsch.*, xvi. 999.) C. F. M. [14

(*Analytical.*)

Determination of nitrogen. — A new method for determining nitrogen, applicable to all nitrogen compounds, is proposed by H. Grouven. It consists essentially in burning the substance at a bright-red heat in a current of superheated steam. He first applied the process on the large scale to the production of ammonium salts from peat, but has since perfected it as an analytical method. The substance is burned in a boat, and the vapors arising from it are passed over a glowing layer of small fragments of a preparation called by the author 'contact-mass', and then through standard acid, as in the soda-lime method. The contact-mass consists of an ignited mixture of peat, chalk, and cement clay in certain proportions, and must be renewed after about fifty combustions. The advantages claimed for the method are, that combustions may succeed each other rapidly in the same apparatus (constructed of iron, with asbestos stoppers), that large quantities of material (two to three grams) may be used, that no drying or pulverization is necessary, and that it may be combined with an ash determination. Nitrates are dissolved with addition of sugar, sufficient clay is added to make a stiff dough, and the latter is introduced into the apparatus. The method is said to give concordant results, which are slightly higher than those obtained by the soda-lime method. — (*Landw. vers.-stat.*, xxviii. 343.) H. P. A. [15

AGRICULTURE.

Chemistry of 'fairy-rings.' — The formation on pasture-land of so-called 'fairy-rings,' that is, of circles of dark-green grass more luxuriant than the surrounding herbage, has long been supposed to be connected with the growth and decay of fungi, which serve as manure for the grasses which succeed them. The effect has by some been ascribed chiefly to the ash of the fungi, while others attribute it largely to their nitrogen. Two views are possible in regard to the way in which the fungi enrich the soil. They may have the power of attacking those organic and mineral matters in the soil which are not available as food for higher plants, and so of converting them into an available form, or it is possible that they have the power to assimilate free nitrogen from the air, and thus increase the store of this element in the soil. Lawes, Gilbert, and Warington have endeavored to decide between these alternatives by analyzing samples of soil from within, on, and outside of, several such rings. Almost uniformly the percentage of nitrogen in the surface-soil to the depth of nine inches was greatest outside the ring, least within it, and intermediate on the ring. The results of the carbon determinations were similar, but less uniform. The authors conclude that the fungi simply render more available to vegetation materials already existing in the soil; and that, as these materials are taken up and removed in the more abundant growth which follows, the soil is naturally impoverished. This conclusion applies, in the first place, to the nitrogen; but it would seem that it must be equally true of the ash ingredients. Whether there may not also be an evolution of free nitrogen by the fungi, or whether, on the other hand, nitrogen may not be assimilated from the air, are undetermined questions; but the phenomena are explainable without these suppositions. — (*Journ. chem. soc.*, ccxlvi. 208.) H. P. A. [16

GEOLOGY.

Puerco beds in France. — Professor E. D. Cope referred to an analysis by Dr. Lemoine of the marsupial types belonging to the *faune cernaysienne* as having been made considerably later than the speaker's diagnosis of similar forms from the Puerco beds, which belong to the same geological horizon. He claimed, that, as the age of the American formation had been the first to be definitely determined, its name should be applied to the corresponding French deposits. — (*Acad. nat. sc. Philad.; meeting* June 12.) [17

The Allegheny oil-sands. — Mr. C. A. Ashburner stated that he had recently examined the Allegheny oil-fields of western New York, and had been able to determine one or two points of interest both to commerce and to geology. After defining the Bradford and Allegheny oil-fields, the varying horizons of the oil-supply were alluded to. He had determined that the Allegheny oil-sands of New York were not above the Bradford sands of Pennsylvania, but were the same. Investigations extended into Livingston, Steuben, and Wyoming counties, N.Y., established the belief that the sands alluded to belong to the lower Chemung group. Mr. Ashburner further remarked, that, while these sands are doubtless for the most part reservoirs of oil produced in lower strata, some of the material was formed from plants contained in the sands themselves. The oil in Pennsylvania never reaches the reservoirs from above.

Mr. Benjamin S. Lyman stated his belief that the oil always originates in the sand where it is found. — (*Acad. nat. sc.; meeting* June 12.) [18

GEOGRAPHY.

(*Arctic.*)

Northern notes, Atlantic region. — The Germania sailed from Hamburg, June 20, with provisions and instruments for the German expedition at Cumberland Inlet. —— The departure of the Willem Barents in search of the Dutch expedition on the Varna took place as proposed. —— The account recently published of the wintering at Cape Flora, Franz Josef Land, by the Eira party, contains numerous items of interest in connection with the proposed use of this land as a starting-point or base for more northerly expeditions. As might be expected from the insularity of the land, the winter is milder than in the same latitude on the west Greenland coast. The land is probably slowly rising, like most other arctic land. Terraces ninety feet above the sea-level were observed. Resident land-animals, such as reindeer, arctic hares or rabbits, and ptarmigan, there are none. Of wandering arctic animals who live in the sea or on the ice, and are common to the whole frozen region, and sea-birds, there is a certain supply, the former being present the year round, though only male bears occur in winter, and the small auks for two-thirds of the year. The lowest temperature observed was forty-three degrees below zero, Fahrenheit, and this in latitude 80°. —— Tromholt, whose researches into the aurora borealis have proved its connection with electrical discharges from the earth, proposes to spend the winter 1883-84 in Iceland, devoting himself to similar studies with Lemström's apparatus, and on the lines indicated by him. —— The U. S. S. Yantic sailed June 14, from New York, to join the Proteus at St. Johns. Ensign H. G. Dresel, U. S. N., accompanies the Yantic as naturalist. Later advices announce the departure of both vessels from St. Johns for Lady Franklin Bay, June 29. —— The Danish South Greenland expedition has arrived at its field of work, and at last accounts expected to begin operations immediately. — W. H. D. [19

Northern notes, Pacific region. — June 2, the steamship Dakota left San Francisco for an excursion throughout south-eastern Alaska with a large number of excursionists. Similar excursions are planned for July and August. —— The schooner Leo has sailed from San Francisco to Point Barrow, to relieve Lieut. Ray and his party, and to obtain absolute magnetic astronomical and pendulum observations at the station. Returning, Mr. Clarke of the signal-service will relieve the present officer at St. Michaels, Norton Sound, and take charge of the station, which will be the most northern signal-service station then in operation. —— A vessel for the hydrographic exploration of the waters of Alaska, under the auspices of the U.S. coast-survey, is about to be constructed on the Atlantic coast, and sent out *viâ* Cape Horn, it being found that the expense of building her on the Pacific coast would considerably exceed the funds available. —— The last reports from the mines near Juneau, Alaska, are very favorable: the owners of one mine 'cleaned up' $9,000 in April; $80,000 have been refused by the owners of another claim. A number of miners will have preceded Lieut. Schwatka on his journey down the Lewis and Yukon rivers this season, bound to join the Schreffelin party on the Tananah. If these numerous prospectors and adventurers were to record their observations, doubtless much valuable information on other than mining topics might be preserved. —— The rock upon which the steamer Eureka was lost last month proves to be a previously unknown danger. —— The decrease of salmon in the rivers of Oregon and elsewhere has led to much activity in pushing out into the new north-west in search of unpillaged streams. A great many new salmon-fisheries have been established at various points in British Columbia and Alaska. —— The U. S. S. Adams is to visit the island of Kadiak on her summer cruise. —— The authorities of British Columbia have instituted an exploration of the Queen Charlotte Islands with reference to agricultural lands. The north-eastern portion of the northern island has been noted for nearly a century for its attractive aspect. The Hudson Bay company has long had a station at the entrance of Massett Inlet (named Hancock River by Capt. Crowell of Boston in 1791), where potatoes and other vegetables flourish; and the fat and sleek appearance of the cattle has been often mentioned by more recent visitors. The western coast of these islands has hardly been visited by explorers since Ingraham, in 1791, made his sketch-map of the coast. It is high and mountainous as far as known, and, like the south-eastern part of the group, likely to be chiefly valuable for its timber, minerals, and fish. —— The body of a white man murdered by the British Indians has been found near Milbank Sound, concealed near the shore; while two Alaskan Indians, who enlivened a visit to British Columbia by slaying two Chinamen, have been sentenced to be hanged at Victoria, V.I. —— The steamer Pinta of the U. S. navy, which was prepared for police-duty and exploration on the Alaskan coast, and lately pronounced unseaworthy, has been re-examined, and the decision reversed: she will sail shortly *viâ* Cape Horn under the command of Lieut. Uriel Sebree, U.S.N. This voyage will offer excellent opportunities for scientific observations *en route*. —— The U. S. S. Corwin, under the command of Capt. Healy, has sailed under instructions to visit Juneau, and settle certain quarrels between American and British miners there, then to proceed to the Pribiloff Islands to protect the seal-fisheries; after which St. Lawrence Bay, Bering Strait, will be visited, and the presents from the government to those hospitable Chukchis who preserved the lives of the Rodgers party will be delivered, arctic whiskey-smugglers looked after, and the usual observations made. — W. H. D. [20

BOTANY.

Cryptogams.

Notes on Laminariae. — In the fourth part of his Observationes phycologicae, Prof. J. E. Areschoug gives a revision of some species of Laminaria and related genera, including several of the forms found in the United States. He considers that L. platymeris, De la Pyl., is the same as L. Cloustoni, which he places in the genus Hafgygia, to which he considers that L. Andersonii also belongs. — W. G. F. [21

Iowa fungi. — Professor J. C. Arthur gives very full descriptions of twelve species of Iowa Uromyces, including one new species, U. acuminatus, on Spartina. At the end is an index of synonyms and host-plants. — (*Bull. Minn. acad.*, ii.) W. G. F. [22

Injurious Algae. — In a paper on some Algae of Minnesota supposed to be poisonous, Prof. J. C. Arthur gives an account of a species of Rivularia infesting the water of ponds at Waterville, Minn., and supposed to be the cause of death or injury to cattle. He also describes the condition of Lake Phalen, near St. Paul, in which he found several species of Nostochaceae. — (*Bull. Minn. acad.*, ii.) W. G. F. [23

Ohio fungi. — In a continuation of his paper on the mycologic flora of the Miami valley, Mr. A. P. Morgan gives a description of the Hyporhodii, Dermini, Pratelli, and Coprinarii of the region mentioned, including sixty-five species. — W. G. F. [24

Phenogams.

Formation of cystoliths. — Chareyre has examined the development of these bodies with special reference to the source of the materials from which they are produced. He finds that the food-reserve in seeds of Urticaceae is composed of aleuron grains possessing 'globoids;' and yet the calcareous matter forming the globoids, though disappearing at the period of germination, does not contribute to the formation of the cystoliths. Sometimes, when grown upon pure sand, the seedlings exhibit the *pedicle* of the cystolith, but nothing more. Upon chalky soil, or even ordinary earth, the cystoliths appear very soon, — in fact, as soon as the cotyledons are disengaged from the seed-coats. If the seeds are made to germinate in darkness, even if other conditions are favorable, the cystoliths remain in the rudimentary state. Furthermore, in some cases, cystoliths already formed disappear upon keeping the plants in darkness. — (*Comptes rendus*, May 28.) G. L. G. [25

ZOÖLOGY.

Coelenterates.

A new hydroid polyp. — Professor E. D. Cope described an interesting form of hydroid polyp found in large numbers on the bark of submerged trees in Upper Klamath Lake, Oregon. Its coenoecium is a mass of creeping yellowish stems embedded in sarcode. Each zoöid is of an elongate oval form, sessile, and with six rays of equal size, each one-half as long as the body. The zoöids are translucent, but with two oval bodies in the lower half of the body-cavity of a yellow color. These are collected in masses as large as the fist. The length of each zoöid is one millimetre. They did not extend themselves beyond this length, neither did the rays elongate to beyond half the same during the time they were observed. They retracted themselves on being irritated. They do not possess any fringes like the arms of the polyzoa. As the possession of a coenoecium distinguishes this genus from all the fresh-water hydroids, it was proposed to distinguish it as the type of a new genus with the name Rhizohydra, the species being named flavitincta. An attempt to preserve some of the masses of zoöids in alcohol was not successful. — (*Acad. nat. sc. Philad.; meeting* June 19.) [26

Mollusks.

Abyssal mollusks. — The fifth part of the Mollusca of the Lightning and Porcupine expeditions, by Dr. J. Gwyn Jeffreys, has been received. It treats of the Solenoconchia, Polyplacophora, Docoglossa, and scutibranchiate limpets, contains supplementary notes to the preceding four parts, and is illustrated by two excellent plates. The number of species first described herein is not large; but a surprising number of facts as to distribution, synonymy, biography, and external anatomy, are brought together. In adopting a later name than Acmaea for that genus, he observes that in the original description no type or species was mentioned by Eschscholtz, but has apparently overlooked the fact that the same is true of the genus Tectura, by which he would replace Acmaea. —— Parts xv. and xvi. of the preliminary descriptions of the Mollusca of the Challenger expedition, by Rev. R. Boog-Watson, are at hand. They cover the Ranellidae, Muricidae, Scalariidae, and Solariidae in the first, and the Fissurellidae and Cocculinidae in the second part. Quite a number of the species are from comparatively shallow water. Eight new species of Puncturella were obtained from one dredging at a locality north of Culebra Island, near St. Thomas, in the Danish West Indies. One of these is the largest yet known. The common Puncturella noachina Linn. of British, north-east American, and Alaskan seas was obtained in the Straits of Magellan, at Kerguelen Island, and at a station between these two, which seems truly remarkable. The operculum of Nassaria kampyla Watson, and the dentition of a new species of Cocculina from the Philippine Islands, are figured. The teeth closely resemble in general features those of the American species, except that the median tooth is more, and the major laterals less, developed than in the forms obtained by the U. S. fish-commission. The descriptions are in the full and faithful manner characteristic of Mr. Watson's work. — W. H. D. [27

Crustaceans.

Haemoglobin in the blood of Branchiopoda. — Some years ago E. Van Beneden discovered a double system of circulation in some of the parasitic Copepoda like that in many annelids, and described a complicated system of vessels with true walls, filled with a red fluid containing haemoglobin, but no corpuscles, and entirely distinct from the lacunar system with colorless fluid containing corpuscles. P. Regnard and R. Blanchard find a similar system in Apus, and believe that it exists also in some Cladocera and Ostracoda. Chemical examination convinces them that true haemoglobin is present in the blood of Apus, is always combined with oxygen, and plays some part in respiration. — (*Zool. anz.*, May 7, 1883.) S. I. S. [28

Fresh-water Copepoda. — F. W. Cragin enumerates the genera of free-swimming Copepoda known to inhabit inland waters, describes and figures ten species of Cyclops, half of them new, from Cambridge, Mass., and publishes a translation of descriptions in Russia of several species of Cyclops by Poggenpol. Mr. Cragin notes the occurrence of the gregarinian, Lagenella nobilis, in North American species of Cyclops. — (*Trans. Kansas acad. sc.*, viii. 1883.) S. I. S. [29

Insects.

The male genital armature of Lepidoptera. — Considering how important a use has been made of these organs to distinguish species in nearly all other groups of insects, it is a little surprising to see how few lepidopterists have availed themselves of the excellent marks of distinction they afford. Rambur in 1839 (whose writings Gosse in the paper before us entirely overlooks), de Haan in 1842, and recently Buchanan White, are the only European authors who have paid any attention to these organs in butterflies; and Scudder and Burgess stand alone in this country.

In the present paper, Gosse describes and figures their appearance in eleven species of Ornithoptera, and fifty-six species of Papilio, including our own Thoas and Turnus. In one, P. Schmeltzi, he found a slight asymmetry in the armature of the two classes. Gosse gives new names to nearly all the parts. The side-plates, or flaps, which conceal the whole, he terms, as usual, 'valves;' the inwardly projecting armature of the interior of these, the 'harpes;' the beak-like mesial prolongation of the eighth abdominal segment, the 'uncus;' the unpaired appendage lying between it and the intromittent organ, the 'scaphium.' He has done particular service in the care with which he has reproduced the scaphium, — an organ consisting, in the swallow-tails, of chitinous points on a membranous body, and therefore badly distorted in dried specimens. This portion was studied and drawn after it had been made to assume its natural fresh appearance by absorbing a drop of water. The variety and strangeness of form and armature assumed by these parts, and particularly by the so-called scaphium and harpes, is very remarkable. In his naming of these parts anew, Gosse has burdened us with new terms for organs which are abundantly named already; but they will, perhaps, have their advantages, if they do not survive after homologues in other insects are pointed out. In his remarks on these organs in other butterflies, Gosse fails to see the homologies which exist, and which Burgess points out in part in a paper which Gosse appears not to have seen (*Anniv. mem. Bost. soc. nat. hist.*), and Buchanan White as well (*Trans. Linn. soc., Zoöl.*, i. 358). In brief, it may be stated that the organs in butterflies consist, besides the intromittent organ, of simply an unpaired upper organ, and paired lower appendages; both of which are attached, the upper immovably, to the ninth abdominal segment. The upper organ usually takes the form of a hook, and the lower, of claspers. In the Papilionides, however (including in that both swallow-tails and pierids), the dorsum of the *eighth* segment of the abdomen is prolonged posteriorly into a terminal hook overlying and concealing the true upper appendage, and at first readily mistaken for it, as shown in the swallow-tails by White and in the pierids by Burgess. Burgess also shows that false claspers exist in Danais, differing only from true claspers in not being articulated. Bearing in mind the attachment of the different external organs ancillary to generation, their homologies throughout the insects are not difficult to trace.

Buchanan White termed the 'upper organ' of Scudder and Burgess the 'tegumen,' and their 'clasps,' 'harpagones.' The uncus of Gosse (which on rare occasions is wanting in some swallow-tails) is therefore no proper part of the ordinary organs ancillary to generation, but a prolongation of the eighth abdominal segment. The scaphium is the upper organ, or the tegumen, of White; the valves of Gosse, the clasps of Scudder and Burgess or the harpagones of White; and the harpe, merely the armature of the clasp, which is extremely varied and complex, not only in the group where Gosse has so well illustrated it, but also in many skippers: indeed, this bizarre form of armature, both of 'scaphium' and 'harpe,' is a new indication of the alliance between the swallow-tails and skippers. We may further remark, that, if the old genus Papilio is the sooner broken up by the additional help afforded by these new studies, Gosse will have done systematists a real service. — (*Trans. Linn. soc. Lond., Zoöl.*, ii. 265.) S. H. S. [30

VERTEBRATES.

Chemistry and physiology of blood-serum. — In dogs which have been starved for a period of five or six days, and which previous to the commencement of the starvation had been fed for two or three weeks on horse-flesh freed as far as possible from fat, Burckhardt finds a diminution in the total amount of proteids in the blood-serum, the loss varying from 4% to 16% of the original amount of proteids present. Of the two proteids of serum, the quantity of serum-globulin increases during starvation, the increase ranging in his experiments from 22.8% to 66.4% of the quantity present before starvation. Serum-albumen, on the other hand, suffers a marked diminution, from 5.3% to 21.66% of the normal quantity. A calculation of the probable loss of albumen from the blood and lymph on the basis of his experiments, when compared with the amount of urea excreted by dogs, according to Voit, in the first five days of starvation, shows that the quantity of albumen lost from the circulating liquids is much too small to account for the proteid destruction indicated by the urea. Burckhardt made use of dialysis chiefly in determining the quantity of serum-globulin present in serum. The serum-albumen was estimated as the difference between the total proteids and the serum-globulin. He states that Hammarsten's method of obtaining serum-globulin by means of $MgSO_4$ is not reliable. Complete saturation with $MgSO_4$ throws down not only the serum-globulin, but also a large amount of proteid, which resembles serum-albumen, as usually understood, in every respect except in its precipitation by $Mg.SO_4$. — (*Arch. exper. path. pharmak.*, xvi. 322.) W. H. H. [31

Double staining blood-corpuscles. — Dr. Vincent Harris has made a series of systematic experiments on double staining of nucleated blood corpuscles with aniline dyes, and gives in connection therewith a table of the aniline dyes, and their solubility in water and alcohol. A little blood was dried rapidly in a thin layer on a slide, and treated with two dyes in succession. The only entirely successful combinations were the following: rosein and aniline green, fuchsin and methylen blue, fuchsin and Bismarck brown, eosin and resuvin, iodine green and Bismarck brown, Hoffman's violet and Bismarck brown, aniline violet and methylen blue. The greens were not at all permanent. The results were often variable and uncertain. For success the solutions must be quite fresh. The time each dye is allowed to remain greatly affects the results. — (*Quart. journ. micr. sc.*, 1883, 292.) C. S. M. [32

The primitive mouth of vertebrates. — According to Rauber, the gastrula mouth (original blastopore or prostoma) is represented by various parts in vertebrates. In Pretromyzon, sturgeons, and Amphibia it is undivided. In sharks it is divided into two parts; i.e., primitive furrow, and posterior marginal opening. In birds it consists of the primitive furrow and marginal notch of the germinal area, and includes also the various small openings formed at the terminal swelling of the embryo; viz., the neurenteric canal, the passage observed by Gasser in the embryo of the Cochin-China breed of hens, and the break which sometimes occurs between the allantois sack and the ectodermal ingrowth behind the tail (caudal sack).

Rauber also asserts in the same paper that the bilateral outgrowths from the primitive streak of amniote embryos are homologous with the divesticula forming the mesoderm in Amphioxus. — (*Zool. anz.*, vi. 143, 163.) [33

Reptiles.

Venom of serpents. — The constitution of the venom of certain of the poisonous serpents has been examined by Mitchell and Reichert with interesting and somewhat remarkable results. According to them, three distinct proteids may be isolated from the venom of the moccason and the rattlesnake (C. adamanteus). These they propose to call respectively, venom-peptone, venom-globulin, and venom-albumen. The venom-peptone may be obtained from fresh venom, or from the aqueous solution of the dried material by dialysis, or by boiling and filtering off from the precipitated proteids. It is soluble in water, not coagulated by boiling, and readily dialyzable. Its solutions, while answering to all the general tests for peptones, exhibit certain peculiar reactions which distinguish it from the class of peptones as usually understood. The most marked of these specific reactions are its precipitation from aqueous solutions by saturation with potassium hydroxide or sodium chloride, and by the addition of dilute acetic acid. Its solutions possess the poisonous properties of venom, though in a less marked degree, giving rise to putrefactive changes when injected into the living animal.

The solution of the peptone obtained by boiling venom, and filtering from the precipitate of coagulated proteids, breaks up on drying with the formation of two proteids, one of which is soluble, and gives all the reactions of the original substance, with the exception that it is not poisonous. The other is insoluble in water, and likewise innocuous.

If an aqueous solution of venom is allowed to stand for some time, a precipitate occurs which gives the usual reactions of globulins. This substance possesses all the toxic powers of fresh venom.

After the separation of the peptone and globulin, a third proteid remains in solution which is apparently closely connected with the albumens, though the authors have not been able to obtain it in a state of sufficient purity to make decisive tests. It is soluble in water, coagulates below 70° C., and is precipitated from its solutions by weak alkalies and acids. It is probably not poisonous. — (*Medical news*, April 28, 1883.) W. H. H. [34

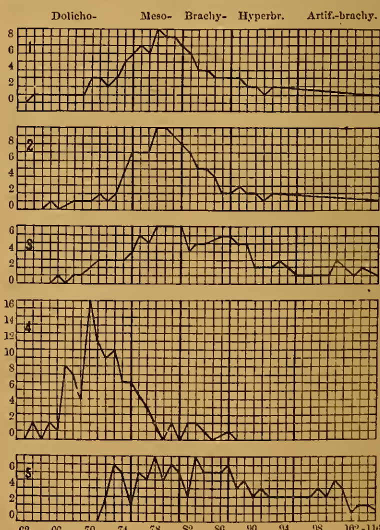
Mammals.

Cutaneous nerves in mammals. — Dr. Harrison Allen has succeeded in tracing nerve-filaments to the larger setae-bearing hair-follicles in mammals as exposed after depilation. He believes that the hair-follicles of the oral, the mental, the supra-orbital and the disto-carpal tufts, as well as those placed on the lateral aspects of the limbs, are in all cases supplied with nerve-filaments, as are the pteryls of birds. In specimens in which the follicles are rudimentary there is a corresponding failure of the nerve, thus indicating a close relation between the two. — (*Acad. nat. sc. Philad.*; *meeting* June 12.) [35

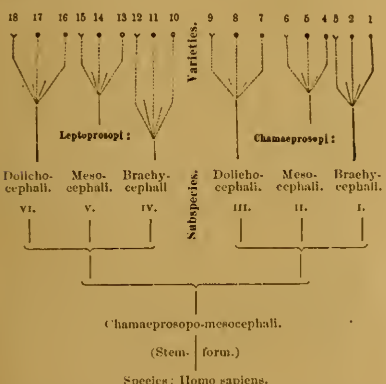
Nerves of the human eyelid. — Von Mises describes the results of his studies. The nerves enter in bundles from the sides as well as from above, and are distributed more or less parallel with the blood-vessels, and form a rich plexus along the edge of the lid. Some details are given as to the distribution of the nerves to the conjunctiva. — (*Sitzungsb. akad. wiss. Wien*, lxxxv., *abth.*, iii. p. 172.) C. S. M. [36

ANTHROPOLOGY.

The autochthones of America. — Dr. J. Kollman of Basel gives his views of American craniology, based on a study of the breadth indices of 1,500 crania, quoted from published measurements, and representing all the countries between Bering Strait and Tierra del Fuego. Five curves are appended,



which reproduce graphically the breadth indices of five groups of American skulls. Curve I. represents 1,292 crania of aborigines of America, whether from ancient Indian burying-places or picked up on recent battle-fields; curve II., 917 North Americans, including the territories of the United States and British America, with the exception of the Eskimo; curve III., 248 Central and South Americans, including the Mexicans on account of their peculiar civilization; curve IV., 127 Eskimo, consisting of all crania from the arctic regions of North America; curve V., 208 pre-Columbians, discriminated from other North Americans by their manner of burial, i.e., mound-builders and stonegrave people. A study of these teaches, 1°. The plurality of varieties in America; 2°. The diffusion of these varieties over the whole continent. As an illustration, the stonegrave people of Tennessee are cited. Their remains are those of a single people, as Mr. Putnam has shown by the correspondence of their customs, and grade of civilization; while the measurements of their skulls by Mr. Carr show a varying proportion of dolichocephali, mesocephali, brachycephali, and artificially shortened crania. A people is an ethnic unity, which, according to the results of craniology, may consist of an anatomical plurality of races; but a race is an anatomically characteristic variety of the human species. Like the Germans, the mound-builders consist of many races, which have combined to an ethnic unity. The term 'race,' as here employed, is equivalent to a sub-species of the species Homo sapiens of Dr. Kollman's system, illustrated by the following diagram.



The varieties are distinguished by peculiarities of the hair: 1, 4, 7, being smooth-haired, indicated by the sign ○; 2, 5, 8, etc., straight-haired, by the sign ●; 3, 6, 9, etc., woolly-haired, by the sign V. So far as is known, only straight-haired varieties have immigrated into America, of the following sub-species: 1. Broad-faced dolichocephali (Eskimo); 2. Broad-faced mesaticephali (Indians); 3. Broad-faced brachycephali (mound-builders); 4. Long-faced brachycephali (ancient Peruvians).

Like the European, the American varieties of the species Homo sapiens have long since passed into the condition of permanent types. The time of elasticity, of the organization of new physically diverse forms, has long gone by. Wherever human remains are found in the glacial formations of Europe, they are as highly organized as to-day. Undoubtedly they represent men of a lower plane of civilization. It is erroneous at every footstep of advance in civilization to infer a new and more highly organized race. Craniology demonstrates that varieties, unchanged physically since the glacial epoch, are continually making their way to higher grades of civilization. — (*Zeitschr. ethnol.*, 1883, 1.) C. A. S. [37

Madagascar. — The vast island of Madagascar, 960 by 300 miles in extent, is unique in its proximity to a continent with which it has such feeble connections. Its population is about 4,000,000; but it is subject to great fluctuations through epidemics, witchcraft, infanticide, intertribal wars, and murders. The peculiar formation of the island effects a tropical, malarial climate around the coast, and a nearly temperate climate elsewhere. All around the island there is a belt of forest, often splitting into two parts, which enclose fertile valleys teeming with people. The natives are the Hovas, of Malay origin, and the Malagasy proper, of African origin, who for the past hundred years have been augmented by importation of slaves from central Africa. The system of government among the negro tribes is purely African in form. Among the Hovas, however, a queen holds sway, through the agency of a prime-minister, who is *ex-officio* husband of the queen. The religion of all the Malagasy is fetishism, with a shadowy recognition of a superior power. They believe in ghost-souls who are capable of good or harm to us, and this belief leads to great respect for the dead. Their beliefs, witchcraft, burials, roads, commerce, and language have been carefully studied by Dr. G. W. Parker, who has communicated a paper on the subject to the London anthropological institute. The island became known to the Portuguese, Dutch, French, and English early in the seventeenth century; although the Arabs traded there long before that. At the beginning of the present century the Hovas became the firm friends of the English, — a connection which has remained unbroken except during the reign of Queen Ranavalona I. Upon the assassination of her son, Radama II., the present system of queens and prime-ministers began.

The languages belong to the class of purely spoken tongues, no one of them having ever been reduced to writing by the natives. The vowels are *ah*, *ay*, *ea*, *ō*, *oo;* the consonant sounds, *b*, *d*, *f*, *g*, *h*, *j*, *k*, *l*, *m*, n, *ng*, *p*, *r*, *s*, *t*, *v*, *z;* the diphthongs are *eye* and *ow*.

The number of consonantal combinations is very small, which occasions many euphonic changes in compounds. The meaning of words and sentences depends little on the tone, but much on accent, position, and the discriminative particle *no*.

Onomatopoeia is common. The grammatic structure is quite regular. A large percentage of the words are traceable to verbal and denominative roots, which are affixed and compounded to an indefinite extent. Gender is indicated by the affixes for male and female, and there is no distinction between animate and inanimate. The numeral system is decimal, and ends with *tapitrisa* (ended are the numbers), the word for a million. There are two moods of the verb,— the indicative and the imperative. There are two classes of personal pronouns,— the inclusive of the speaker, and the exclusive. Other peculiarities in grammar are pointed out by Dr. Parker in an exhaustive dictionary of fourteen dialects, which unite the Malagasy with the Malay stock-language. To account for this anomaly of race and language, Dr. Hildebrand supposes the Hovas to have first settled the island, and to have been overpowered by African marauders, who killed most of the Hova men, and married their wives. The children, learning their language from the mothers, perpetuated at the same time their African blood and their Malay language. But Dr. Parker seriously objects to this explanation. Mr. Keane is of the opinion that the Africans were introduced as slaves, who, while gradually corrupting the blood, would have little effect upon the language. Dr. G. Oppert also commented upon the paper. — (*Journ. anthrop. inst.*, xii. 478.) J. W. P. [38

The flora of ancient Egypt. — The student of anthropology is repeatedly charmed and surprised by the varied and brilliant illumination thrown upon his subject by sister sciences. He is not less pleased to know that quite frequently the light proceeds in the other direction, and that human custom preserves for other sciences their sibylline leaves. In 1881 Emil Brugsch Bey discovered in the vault of a king of the twentieth dynasty a large number of plants contained in the funeral offerings, repasts, and wreaths of the dead. Among these are several species not known to have belonged to ancient Egypt. Mr. G. Schweinfurth, deputed by M. Maspero, has studied these plants, and classified them in the Egyptological museum of Boulak, according to the high personages for whom they were intended. A very extended and interesting account of these labors was communicated to Sir Joseph D. Hooker, together with a set of the wreaths, flowers, etc., described. Excellent illustrations accompany the paper of Mr. Schweinfurth. These objects were exhibited at the annual *soirée* of the Royal society on the 25th of May, and are now on view at the Royal gardens, Kew. — (*Nature*, May 31.) J. W. P. [39

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

STATE INSTITUTIONS.

Missouri weather service, St. Louis.

Weather report for May. — The average temperature for May at the central station has been 63.4°, which is 2.8° below the normal temperature, and 3.5° above the temperature of May, 1882. Since 1837 the May temperature has fallen below that of last month five times. The extremes during last month at the central station were 38.0° and 88.4°; although, in the suburbs of St. Louis, the temperature fell to 36.0° on the evening of the 21st. In 1851 Dr. Engelmann observed a temperature of 29.0° in May, but it was in the early part of the month. The lowest minimum temperatures reported were, 29.5° at Centreville; 31.0°, at Big Creek, Warren county; 32.0°, at Steelville; all other stations reporting over 34.0°. The highest minimum temperatures are reported from Glasgow, 45.0°, and Harrisonville, 47.0°. The highest maximum temperatures reported were, Corring, 91.0°; Miami, 98.0°; Harrisonville and Big Creek, 90.0°. The highest average temperatures reported were, Cairo, Ill., 65.2°; Mascoutah, Ill., 65.0°; Harrisonville, 64.0°: the lowest being at Keokuk, Io., 59.9°; Macon, 60.4°; Louisiana, 60.5°.

The rainfall at the central station was 2.61 inches, which is 2.2 inches below the normal May rainfall at St. Louis. In western Missouri, however, from Harrisonville northward along the Missouri valley, the rainfall has been over seven inches; and a small maximum of over seven inches occurs in the region around Ironton. An area of minimum rainfall of between two and three inches occurs in south-west Missouri, around Greenfield and Lamar, and another occurs along the lower Missouri below Chamois, extending along the Mississippi as far south as Cairo.

On the 13th, tornadoes occurred at various points in Missouri and Kansas, as follows: the town of Oronogo, Jasper county, was destroyed at about 7.40 P.M., two persons being killed, and forty injured. This tornado is probably the one which passed about two miles north of Carthage. Hailstones as large as hen's eggs fell at Springfield at about 10 P.M. Another storm passed two miles south-east of Pattonsville, Davies county, on the same evening. Two tornadoes passed through Kansas City at 5 o'clock, one passing a few minutes later than the other. Several persons were killed, and a great deal of damage was done to property. These whirls were slender whiplike vortices, the diameter at the surface of the earth being only a few feet, although the destructive path was about seventy feet. These storms originated apparently in Wyandotte county, Kan., where they caused great damage. A later development of this storm passed through Macon City, one hundred and twenty miles east-north-east from Kansas City, where a tornado occurred about 8.30 P.M. The track was from one-fourth to three-eighths of a mile wide. Three persons were killed at Macon.

On the 18th, tornadoes occurred in Missouri, Illinois, and Wisconsin. At 7 P.M. a tornado did considerable damage at Berger, Gasconade county, Mo. At about 8.20 P.M. a tornado passed through Wentzville from the south-west, causing great destruction to property, and loss of life, as far as St. Paul, Mo. At about the same time a storm passed from Cottleville, through Elm Point, to Grafton, on the Illinois shore of the Mississippi River.

Hail-storms have occurred as follows: at Big Creek, 10th; Centreville, 9th; eight miles north of Savannah, 3d; Hannibal, 9th; Louisiana, 9th and 10th (and at Springfield and Dover church, near Louisiana, large hail fell on the afternoon of the 18th); Lamar, 3d; Chamois, 9th, — a violent storm of wind and hail at 7 P.M., for seven to ten minutes, the hail completely covering the ground, some stones weighing six ounces. On the 18th, at 5.50 P.M., a dark cloud in the south-west moved to the west with a heavy roaring noise, appearing to spend its force when due west, rain and small hail following.

Killing frosts occurred on the nights of the 21st and 22d. At Big Creek great damage was done to wheat, corn, and fruit. At Centreville, at 9 P.M., on the 21st, the temperature was 32°, and fell later to 29.5°, — the latest frost in sixteen years. Fog prevented damage in the valleys of the Black River, but in the dry valleys every thing was killed. Louisiana, 32° at sunrise on the 22d; Chamois, destructive frost with ice an eighth of an inch thick in a pan of water; Greenfield, heavy frost, which injured foliage of forest-trees so that they looked as though scorched by fire.

White frosts occurred at Hannibal, Greenfield, Mexico, Chamois, 5th; Hannibal, Louisiana, Chamois, Miami, 11th; Ironton, 16th; over the entire state, 21st and 22d, but light in the south-west, where the temperature was about 40°; Mexico, Ironton (33° at 5.30 A.M.), Louisiana, Chamois, Miami, Greenfield, 23d; Sedalia, Centreville, Greenfield (heavy), Ironton, Chamois, Miami, 31st.

ADDENDUM to April report. — At Cairo a heavy shock of earthquake was felt at 2.36 A.M. on the 12th, which lasted thirty seconds. Vibrations, three per second, from south-south-west to north-north-east. An old one-story frame-building, which was occupied at the time the shock occurred, was shaken down and collapsed, the inmates receiving slight injuries.

Iowa weather service, Iowa City.

Weather bulletin for May. — May was remarkably cold, very rainy, with late frosts, westerly and northerly winds prevailing. The mean temperature of the air was nearly five degrees *below* normal. In forty-five years, May has been six times as cold or colder than this year; namely, in 1882, 1867, 1858, 1851, 1850, and 1849. The late frosts about the 12th and 22d were general.

The rainfall was much above normal throughout Iowa, except in middle northern Iowa and down the middle Cedar and Wapsipinicon valleys. The total rainfall was highest along the Mississippi and Missouri rivers, and from Wayne to Polk county: in the regions here specified, the rainfall averaged seven inches. The rain frequency was also high: two of every three days were rainy in most parts of the state.

The principal storm-days were the 8th and 9th, the 13th and 14th, 17th and 27th. On the 9th a very small tornado did slight damage in Linn county, near Norway station: on the other storm-days, Iowa was spared the visitation of tornadoes, which struck, on the 13th, Kansas City; 18th, Racine; 28th, southern Indiana.

While unusually cold and quite wet, the season is much more promising than last year, when May was much colder.

NOTES AND NEWS.

Stephen Alexander, professor emeritus of astronomy at Princeton, died June 26. He was born at Schenectady, N.Y., and was educated at Union college, where he graduated in 1824. Since 1840 he has been connected with Princeton, first as professor of astronomy, and later as professor of mechanics as well. As an astronomer he became widely known.

— Sir Edward Sabine, whose death has been lately announced, was born in Dublin in October, 1788. He studied at the military schools of Marlow and Woolwich, and at the age of fifteen entered the English army. In 1813 he was made captain, and took part in the campaign on the Niagara frontier, commanding the batteries at the siege of Fort Erie, 1814. From 1818 to 1825 he made a number of voyages from the equator to the arctic regions for the purpose of studying terrestrial magnetism, the figure of the earth, and other questions in terrestrial physics. He was with Ross and Parry on the arctic expedition of 1818, and with Parry the following year. He edited a number of translations of scientific books, and published a large number of papers on his favorite studies, having read more than forty before the Royal society, and having contributed many to the proceedings of the British association. From 1827 to 1830 he was secretary of the Royal society, and president for the ten years 1861 to 1871, and president of the British association in 1853. In 1875 the French academy elected him as a corresponding member.

— A few weeks ago (April 26) *Nature* gave a sketch of the life of Spottiswoode. In the number for June 14 we find a regret expressed at his absence, on account of sickness, from the Royal society meeting of that week. On June 27 he died. Born in London, Jan. 11, 1825, he began his education in a private school at Laleham, and then at Eton and Harrow; his stay at Eton being short on account of some experiments with detonating mixtures, in which he was found to be interested. In 1842 he entered Balliol college, Oxford, where, in his last year (1845) as undergraduate, he read with the Rev. Bartholomew Rice. After graduation he held university mathematical scholarships for two years, and for a short time lectured on geometry of three dimensions. But he soon took an active part in the management of the large printing-business about this time resigned to him by his father, and which he largely developed. His scientific work was mainly in mathematics, although of late years he has devoted himself to physics, his recent investigations in electricity being well known. When a young man, he travelled widely, and, among others, published a very lively account entitled "A Farantasse journey through eastern Russia in the autumn of 1856." He also studied languages, both oriental and European, and gave evidence of the thoroughness of these studies in his contributions to our knowledge.

—The Dickson expedition, in charge of Professor Nordenskiöld, which left Thurso May 29, is reported as having called at Reikiavik, Iceland, June 6, and was to sail for Greenland on the 10th. When the expedition started, it was the intention that Count Stromfeldt (botanist), Dr. Arpi (philologist and archeologist), and Mr. Flink (mineralogist) should disembark at Reikiavik, and remain in Iceland for study and exploration. It is reported by recently arrived whalers that the condition of the seas west from Iceland, as regards ice, is at present not unfavorable to the success of the expedition. The Sofia, upon which the party is embarked, is a little iron propeller of less than two hundred tons, capable of a speed of eleven knots, and draws ten feet of water, —a vessel much better suited to her purpose than the unwieldy craft which have been used in many of the English expeditions. It was originally intended that Palander should command the Sofia, but circumstances intervened to prevent this; and the vessel has been intrusted to Capt. Emil Nilsson, who is well qualified by experience, and who will be ably seconded by the well-known Norwegian ice-master, Johannesen. The scientific staff does not comprehend any of the members of the Vega expedition, who are mostly engaged in working up the investigations made on that voyage, but, after Baron Nordenskiöld, is composed of Dr. Kolthoff, entomologist and ornithologist; Dr. Nathorst, geologist and paleontologist; Dr. Berlin, surgeon, botanist, and general biologist; Mr. Forsstrand, taxidermist and preparator; Dr. Hamberg, hydrographer; Mr. Kjellström, photographer. Beside these, there are a harpooneer, two mountain Lapps (in accordance with the suggestion of Professor Fries, to which we have already alluded), and eight or nine picked men, to accompany the party over the inland ice. This party will be provided with fourteen months' provisions in the most compact shape possible. The crew of the Sofia comprises twenty-four men. The party is thoroughly equipped with scientific apparatus, and even includes a flying-machine contributed for trial by its inventor, according to the Swedish papers.

—Among the most interesting of the living animals in the gardens of the London fisheries exhibition are two British-born beavers from the Isle of Bute in Scotland. They were members of a colony established by the Earl of Bute upon his estate of Rothesay several years since. A considerable tract of land was walled in, and beavers were imported from Canada, which soon established themselves, gnawing down the trees, building a dam, and forming a lake of considerable size. The 'beaver wood' is considered one of the most interesting features of the island. Mr. R. B. Matthews writes to the *Field*, complaining, that, in capturing the two beavers to send to the exhibition, the colony has been broken up, the dams destroyed, the houses pulled down, and all the other beavers killed. It is to be hoped that the damage is not so serious as is represented, for the acclimation of the American beaver in Scotland is a task which is not likely to be often attempted.

—The next issue of the Proceedings of the naval institute (vol. ix. no. 3; whole no. 25) will be entirely devoted to an article by Lieut. Edward W. Very, on the development of armor for naval use. The number will thus be a complete work of itself, fully illustrated, and will possess more than ordinary interest in being the only work extant devoted exclusively to the details of armor development. Orders for this number should be sent to the secretary U. S. naval institute, Annapolis, Md., as early as possible. Price $1.

—The extraordinary meeting of the geological society of France for this year is to take place at Charleville (Ardennes) on Sunday, Sept. 2, and the excursions will end Tuesday, Sept. 11.

—The yearly meeting of the Schweizerischen naturforschenden gesellschaft will take place from the 6th to the 9th of August in Zurich, where the national exposition is attracting many people this year.

—G. Valentin, for forty-five years professor of physiology at the university of Berne, died on the 24th of May at the age of seventy-three. He was a native of Breslau. He was formerly one of Louis Agassiz's collaborators; and the fourth *livraison* of Agassiz's 'Monographies d'echinodermes vivants et fossiles', containing the anatomy of the genus Echinus, is by Valentin.

—Past assistant-engineer N. B. Clarke, U. S. N., read a paper on water-line defence and gun-shields for cruisers, at the meeting of the U. S. naval institute (Washington branch) on June 7.

—The bureau of education has issued, as one of the 'circulars of information,' a pamphlet containing the legal provisions respecting the examination and licensing of teachers.

—A contributor's note in the *Atlantic monthly* for June calls attention to the question of the spelling and pronunciation of geographic names, on which several articles have lately appeared in foreign journals. The question is not always settled by adopting local spelling and sound, for in many cases foreign names are well Anglicized, and will so remain; the difficulty is rather in knowing where to begin using the original pronunciation. As we do not say Paree and Bairleen, why may we not say Prāgue and Hāgue, even though we do drop a visible *s* from Calais, and attempt the difficulties of Rouen, Amiens, Chartres, and Blois? As to St. Petersburg, the error of sanctification is not ours, but the Russians', from whom we have taken it. Our mistake, if it be one, is in putting an *s* after Peter, for this seldom occurs in the original. A similar but incorrect addition is often made in Prince Edward Island. The back-and-forth method of naming seen in the German *Vogesen*, which the contributor explains as coming from the original German *Wassigen* (watery), through the French *Vosges*, is found again in the same polyglot borderland in the *Laacher See*.

— The Comision del mapa geologico de España has just published, for the Exposicion de mineria at Madrid, a brief account of the history of the survey from its beginning, about the year 1831, under D. Angel Vallejo, down to the present time. Two maps show the condition of the work in March, 1873, at the beginning of the present system of the survey, and in March of the present year, showing how great an amount of work has been done in the last ten years. Eighteen provinces are finished; viz., Oviedo, Madrid, Santander, Castellon, Albacete, Murcia, Teruel, Cadiz, Zaragoza, Cuenca, Cáceres, Valladolid, Huesca, Avila, Salamanca, Guadalajara, Barcelona, and Valencia. More or less has been published concerning twenty-three other provinces, but their full descriptive memoirs are still to appear; viz., Coruña, Lugo, Orense, Pontevedra, Segovia, Palencia, Baleares, Alicante, Burgos, Logroño, Soria, Alava, Guipúzcoa, Vizcaya, Tarragona, Huelva, Toledo, Badajoz, Cordoba, Ciudad-Real, Granada, Navarre, and Almeria. Seven provinces are entirely unpublished or under study; namely, León, Lérida, Zamora, Málaga, Gerona, Jaén, and Sévilla. A rough draught of the final map, on the scale of 1 : 400,000, is shown in the exposition, upon which all the work done up to date is entered.

— The Belgian photographic association has organized an international exhibition of photography to be held, during the month of August, 1883, in the palais des beaux-arts at Brussels.

— The sixth international congress of orientalists will be held at Leyden, Sept. 10.

— The international congress of societies for the prevention of cruelty to animals will be held at Vienna in September. A number of local societies, among them those of Berlin, Cologne, Munich, Dresden, and Hanover, besides several Spanish Italian, and Russian, have expressed their intention to be represented.

— The British association for the advancement of science meets this year at Southport, Sept. 10.

— Dr. William Lee read before the Philosophical society of Washington, June 2, a paper on medical history as illustrated by medals; Prof. Theo. Gill discussed analogues in zoögeography. The society then adjourned till October.

The Mathematical section of the society adjourned for the summer on June 6. At the last two meetings, Mr. G. W. Hill discussed the planetary perturbations of the moon, Mr. G. K. Gilbert explained the construction of graphic tables for use in connection with his new method of determining heights from barometric data, and Mr. E. B. Elliott gave an improved system of electrical units.

— An excursion to northern Norway and Spitzbergen is projected for some of the students at the Paris École des mines. Two French naturalists will accompany the party, which will charter a steamer directed by a competent arctic navigator for the purpose.

— Professor Fries has proposed the colonization of Greenland by Lapps, on the hypothesis that in the interior, in summer, abundant reindeer-pasture can be found. How the reindeer are to get at it does not seem to have been considered, nor how they are to be subsisted during their travels over the continental ice-sheet.

— Mr. Oliver W. Huntington, assistant in the chemical laboratory of Harvard college, has edited a book of five-place logarithms, which will finally form part of a set of tables mostly for use in chemical calculations, but is now published in separate form. The logarithm tables are well arranged, and very clearly printed. The book is published by Moses King, Cambridge.

— The museum at Oxford, Eng., has lately bought the unique collection of Silurian fossils of Dr. Grindrad of Malvern.

— It is rare to find, at the present time, a scientific memoir in Latin. Aloysius Molina, a student at Pisa, has, however, recurred to the ancient custom, and has published a memoir, 'De hominis mammaliumque cute,' in volume v. of the *Atti della società Toscana.* The opening sentence sufficiently describes the paper: "Expectans dum Ranvierus in lucem perfecte proferat conclusiones omnes suarum investigationum de intima structura cutis, prodesse existimo breviter quae praecipua facta sunt resumere, nonnullas considerationes addens, quas ipse feci dum per duos annos ad Anatomicam Scientiam meum adhiberi studium in Laboratorio Anatomiae Comparativae hujus universitatis." The 'nonnullas considerationes, quas ipse feci' one finds not very numerous, the chief value of the paper being as a summary. A good bibliography is appended.

— Much progress has been made at the Lick observatory during the past year. The dome for the twelve-inch equatorial has been entirely completed in a very thorough manner. It is, without any doubt, the most convenient and complete dome of the size in the country. The four-inch transit-house, and the buildings for the photoheliograph, are in capital working order. They were utilized last December in a very successful observation of the transit of Venus. The walls of the main building are half done, and the cellar for the dome of the thirty-six-inch equatorial is excavated. Many of the original arrangements of the buildings and grounds were only provisional, and these are being replaced by others more substantial and permanent. A brick reservoir containing 83,000 gallons of water (derived from three springs) has been built during the season; another of 20,000 gallons (spring-water), and another of 83,000 gallons (rain-water), will shortly be begun. The roads have been extended. The house for the meridian circle (Repsold) will be begun in a few weeks, as well as a house for the astronomers, and buildings to contain the appliances for heating and lighting the buildings and moving the dome. The end of this season will show great progress.

— The division of entomology of the U. S. department of agriculture has begun the publication of a series of bulletins for the purpose of placing before the public, current matter that would either lose much of its value if kept for the annual report, or find no space in the limited pages of that volume.

Two numbers have been issued. The first includes reports of experiments, chiefly with kerosene, upon the insects injuriously affecting the orange-tree and the cotton-plant. The second includes reports of observations on the Rocky Mountain locust and the chinch-bug, together with extracts from the correspondence of the division on miscellaneous insects.

— The University of Pennsylvania has conferred the degree of M.A. on Professor Lewis M. Haupt, C.E.; and of Sc.D. on Professor Isaac Sharpless, professor in Haverford college.

— At the meeting of the Royal astronomical society, May 11, Professor C. Pritchard of Oxford gave an account of his recent expedition to Cairo, and of the work on which he has for the last two years been engaged; viz., the measurement of the magnitude of the stars visible to the naked eye from the pole to the equator, including at present all those brighter than the fifth magnitude. This work is now complete. He found, that, at Oxford, Laplace's law of alteration of a star's light as measured in magnitude — according to the secant of the star's zenith distance — did not hold good for zenith distances exceeding 65°, and that for stars at lower altitudes the alterations in apparent magnitude were conflicting and not satisfactory. For the purpose of accurately investigating the effect of atmospheric extinction of light under better circumstances, he chose the climate of Upper Egypt, where the atmosphere is uniform and stable, as the proper locality for repeating the Oxford observations, and rendering the research complete. A duplicate set of instruments was left at Oxford in charge of the senior assistant, who observed the same stars with Professor Pritchard at Cairo. The results of both sets of observations are embodied in the formulae, —

Atmospheric absorption
At Cairo $= 0.187 \times$ Sec. Z.D. in magnitude;
At Oxford $= 0.253 \times$ Sec. Z.D. in magnitude.

Thus the whole effect of the atmosphere at Cairo is to diminish the brightness of stars seen in the zenith by about two-tenths of a magnitude, and at Oxford by about one-fourth of a magnitude. At an altitude of about 30°, the stars at Cairo will be brighter than in England by about one-fifth of a magnitude, and consequently many more faint stars are just visible at Cairo than can be seen at Oxford.

— Alexander Melville Bell has written a primer, which will soon be published, for use in elementary schools in teaching the methods of visible speech. The book can be used by any teacher without special training in the peculiarities of the system.

— A correspondent states that the shortest scientific article known to him, and perhaps the shortest ever published, is by William Griffith, in the bulletin of the U. S. fish-commission for 1882, p. 12, under the title 'Result of planting shad in the Ohio River.' The article contains twenty-six words, and occupies two lines.

— At the meeting of the Cambridge entomological club, June 8, Mr. S. H. Scudder discussed the homologies of the male abdominal appendages of butterflies, and Mr. G. Dimmock showed a living Buthus occitanus, and described some of its habits.

— The Argentine government has sent Col. Solá, with a party of two hundred soldiers, to explore the Pilcomayo in its course through the Gran Chaco. The party is accompanied by a delegate of the Argentine geographic institute, whose chief object is to discover the remains of Crevaux, and ransom two of his men who are reported to be held as prisoners by the Indians.

RECENT BOOKS AND PAMPHLETS.

**** Continuations and brief papers extracted from serial literature without repagination are not included in this list. Exceptions are made for annual reports of American institutions, newly established periodicals, and memoirs of considerable extent.*

Adam, L. Les idiomes négro-aryen et maléo-aryen, essai d'hybridologie linguistique. Paris, *Maisonneuve*, 1883. 76 p. 8°.

Bisson, E. Nouveau compas de mer donnant la direction vraie du méridien magnétique sur les navires en fer. Paris, *impr. Chaix*, 1883. 20 p., 4 fig. 8°.

Boutillier, L. Des coralloires à madrépores et de leur action géologique. Rouen, *impr. Cagniard*, 1883. 30 p. 8°.

Camoy, J. B. Biologie cellulaire: étude comparée de la cellule dans les deux règnes au triple point de vue, anatomique, chimique et physiologique. Aachen, *Barth*, 1883. 8°.

Crié, L. Les origines de la vie, essai sur la flore primordiale: organisation, développement, affinités; distribution géologique et géographique. Paris, *Doin*, 1883. 79 p., illustr. 8°.

Crozals, J. Les Peulhs, étude d'ethnologie africaine. Paris, *Maisonneuve*, 1883. 271 p. 8°.

Desdevises du Dezert, T. Le noyau central et les marches de la langue d'oyl. Rouen, *impr. Cagniard*, 1883. 28 p. 8°.

Duguit, L. Quelques mots sur la famille primitive, conférence faite à Bordeaux, le 16 mars 1883. Paris, *Larose*, 1883. 32 p. 8°.

Elsner, F. Recepte für pharmacie und chemische grossindustrie. Halle, *Knapp*, 1883. 9+216 p. 8°.

Fabre, J. H. Cours de physique (programmes de 1882). Paris, *Delagrave*, 1883. 304 p., illustr. 18°.

Ferri, L. La psychologie de l'association depuis Hobbes jusqu'à nos jours (histoire et critique). Paris, *Baillière*, 1883. 4+382 p. 8°.

Fricero, A. Considérations diverses sur l'emploi des huiles minérales lourdes dites oléonaphtes comme lubrifiants. Marseille, *impr. Grangé*, 1883. 12 p. 8°.

Greer, H. Recent wonders in electricity, electric lighting, magnetism, telegraphy, telephony, etc., N.Y., *Agent Coll. electr. eng.*, 1883. 168 p., illustr. 8°.

Guyot, A. Memoir of Louis Agassiz, 1807–73. Princeton, *Robinson pr.*, 1883. 49 p. 8°.

Instructions relatives à l'établissement des pépinières de vignes américaines. Paris, *impr. nat.* 1883. 36 p. 8°.

Le Breton, G. La céramique polychrome à glaçures mét. alliques dans l'antiquité. Rouen, *impr. Cagniard*, 1883. 45 p. 8°.

Leplay, H. Chimie théorique et pratique des industries du sucre: étude historique, chimique, et industrielle des procédés d'analyse des matières sucrées, etc., suivie de la description d'un nouveau procédé d'analyse chimique industrielle des matières sucrées. T. i. Paris, *Baudorn*, 1883. 28+452 p. 8°.

Marin La Meslée, E. L'Australie nouvelle. Paris, *Plon*, 1883. 12+298 p., illustr. 18°.

Quenstedt, F. A. Die ammoniten der schwäbischen Jura. i. heft, mit ein atlas. Stuttgart, *Schweizerbart*, 1883. 48 p., illustr. 8°.

Schneider, A. Zoologische beiträge. i. band, i. heft. Breslau, *Kern*, 1883. 3+63 p., 12 lith. 8°.

Tellier, C. Étude sur la thermo-dynamique appliquée à la production de la force motrice et du froid. fasc. i. Paris, *impr. Mouillot*, 1883. 7+97 p. 8°.

Thompson, D'Arcy W. A catalogue of books and papers relating to the fertilization of flowers. London, *Macmillan*, 1883. (2)+36 p. 8°.

SCIENCE.

FRIDAY, JULY 13, 1883.

THE GOVERNMENT AS A PUBLISHING HOUSE.

We have called attention to the report of Messrs. Ames, Spofford, and Baird upon the distribution of public documents, and noted the propriety of the recommendations made to the government by the committee. If these recommendations were to be carried out, something would be gained; but we have little faith that any real reform would be effected, for the evil lies deeper, and requires more radical treatment.

Ever since the government went definitely into the printing business in 1861, the evil has been growing, until now there is waste, confusion, and public mischief. It is no more essential to government to carry on the large printing business which it conducts than it is for it to manufacture paper. Let us make a distinction. There is a necessity, in the ordinary administration of Congress and the executive department, for a large printing-office in the immediate vicinity; and we are quite ready to grant, as immaterial to our argument, that it is better to have such an establishment, with its manager as a civil officer of the United States, immediately under the control of Congress. There is a vast deal of printing required in the exigencies of the daily business of government, and there is reason for this being done by persons hired directly for the purpose.

There the necessity stops, but the business of the printing-office does not. Costly scientific reports are manufactured year after year, and then published; that is, given away recklessly and with little discrimination. The report of scientific experts, to which we have referred, points out the desirability of a single agency for distribution, which should act upon some systematic plan. We do not object to a policy by which government shall put before the public the results of the surveys and experiments which it is carrying on; but we contend, that, in doing this, it should employ economic agencies already existing, which are far more efficient than any immediate governmental agency can be.

Government should contract with publishers to print and publish its scientific reports. The plan is perfectly feasible. Every copy which the government might wish to give away to public libraries could be bought of the publisher at a cost fifty per cent less, we venture to say, than government now pays for the same work. It would be the publisher's business to make the work known everywhere; and such a work would be far more read than it now is, for it would be made as other books are, and brought before the people intelligently. By such a policy no scientific organization or student of science now in communication with the distributing-office would suffer loss, while a great many people who are accustomed to get their books from booksellers would come into possession, in the most natural way, of this important body of literature.

The effect of such a system would be to contract the business of the government printing-office, and that is an end devoutly to be wished for by every honest citizen who sees the necessity of checking corruption by limiting the opportunities for corruption. The fewer salaried offices this government has, the less chance there is for an abuse of the civil service; and science will gain nothing by asking favors of the machine. There is an excellent opportunity here for the educated classes to enter a protest, and to encourage a reform in administration. We have been demanding that the administration should be conducted on business principles; and the present system by which government prints and publishes books is un-businesslike, extravagant, and in peril of being scandalous.

THE NATIONAL RAILWAY EXPOSITION.[1] — II.

The numerous accidents that have occurred owing to the signals showing 'clear' when the switches were set for a side-track led to the invention of 'interlocking,' which is now used extensively in England, and is being introduced into this country. The term 'interlocking' applies to a system where the switches and signals can be so worked by levers concentrated at one point, that no safety-signal can be given for any track until the switches are properly set for the safe passage of the train; and, when the signal is set to safety, none of the switches can be moved until the signal is again made to indicate danger. The advantages of this system are, that one man can operate a large number of switches and signals, and the interlocking apparatus acts as a check upon him, and renders it impossible for him to commit a mistake and move a wrong lever; and the mechanism is so arranged that a certain definite routine must be gone through in making a safe course for a train. The signals standing at their normal position of 'danger,' the switches are first moved, then they are locked firmly in position: then only can the danger-signal be changed to safety for the passage of the train when all possible conflicting signals or switches are locked, so that they cannot be operated. When a certain track has been prepared for the safe passage of a train, the necessary alteration of switches and signals is begun at the point farthest from the train, and ended at the signal nearest to it, this signal being locked to indicate danger until the track is ready for the train; and the setting of this signal to safety shall lock to danger all conflicting signals not already locked.

The amount of safety secured by the adoption of interlocking apparatus is thus laid down by an English author: "If a man were to go blindfold into a signal-box with an interlocking apparatus, he might, as far as accordance between points and signals is concerned, be allowed with safety to pull over any lever at random. He might doubtless delay the traffic, because he would not know which signal to lower for a particular train; but he could not lower such a signal, nor produce such a combination of position of points (switches) and signals, as would, if the signals were obeyed, produce a collision."

Interlocking has been very generally adopted in England, but hitherto little attention has been paid to the subject in this country; though in some crowded depots, such as Lowell, Wilmington (Del.), and Boston (Boston and Albany railroad), it has recently been introduced with great success.

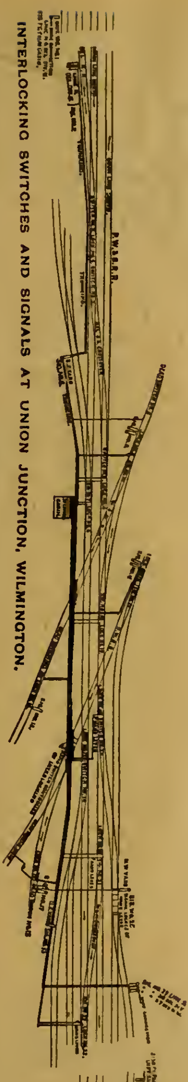
The two principal exhibits of interlocking and signalling apparatus at the Chicago exposition are those of the Pennsylvania steel company and the Union switch and signal company; Mr. George Westinghouse, so well known as the inventor of the break bearing his name, being the president of the latter company. The Union switch and signal company exhibits several distinct methods of working switches and signals controlled by interlocking apparatus. First, the Saxby and Farmer method, which is very generally used in England, and in some station-yards on the continent; Brussels, for example. In this the whole work of moving the signals and switches is effected by the manual power of the signalman. But as this involves considerable physical exertion in places where the levers are numerous, and some of the signals are a considerable distance away, Mr. Westinghouse has introduced a system whereby the signalman only moves valves admitting either compressed air, or a mixture of water and wood, or methylated spirits of wine, to cylinders, the pistons of which perform the actual hard work of shifting the switches and signals. The Pennsylvania steel company shows an American invention, which proceeds on similar lines to the Saxby and Farmer apparatus, attaining, however, the same end by the use of fewer levers. As, therefore, these two systems are very similar, except as regards mechanical details, into which we need not enter here, the following description of the general methods and purposes of interlocking mechanism will apply to both exhibits. The whole question is novel on this side of the water, and will well repay a careful study by all those who are interested in the progress of railroads.

One of the points that has been equipped with interlocking apparatus by the Pennsylvania steel company is shown in the accompanying plan of tracks at the Union Junction of the Philadelphia, Wilmington, and Baltimore railroad, at Wilmington, Del. This junction is one mile west of the passenger-station, at the crossing (at grade) of the Wilmington and northern railroad and of the Delaware western railroad, where the Delaware railroad branches from the main line of the Philadelphia, Wilmington, and Baltimore railroad. Through trains pass this junction at lightning express speed. The main line is protected from crossing roads by dead

[1] Continued from No. 22.

switches on the crossing roads, so that crossing trains running against signals will be turned into a side-track, and cannot, therefore, cross or foul the main line. There are, in all, fifteen switches handled and controlled, and three other switches not handled (owing to the infrequent use, or being required only for hand-drilling), which are also perfectly controlled. Twelve facing point locks and seventeen signals are employed, some of them 2,150 feet from the signal-tower. To operate the above, twenty-eight interlocking levers are used, with two spare levers in the frame for future improvements. At this writing, the apparatus at Union Junction has been in use over one year with perfect success, and it will probably repay any railroad manager to visit it, and study its workings.

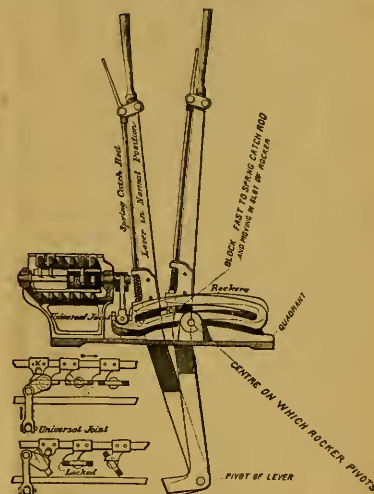
In arranging a yard on the interlocking system, it is important to concentrate the switches so that they can be worked by one man from one machine, where as many as fifty levers operating switches and signals can be conveniently arranged. Provided that the yard is well laid out, it is possible not only to gain greater safety and security in switching and drilling, but a saving in time and labor is effected, as one man who is always on the same spot can perform the



INTERLOCKING SWITCHES AND SIGNALS AT UNION JUNCTION, WILMINGTON.

work of several men scattered about a yard, and having continually to move from one spot to another. The levers should be placed in a house constructed so as to shelter the signalman from the weather, and enable him to have a good view of the whole yard; and the latter object is generally best attained by placing him at some distance above the ground-level, so that his view is not obstructed by passing engines and cars.

The levers, which resemble the reverse lever of a locomotive, are mounted close together in a line, and a name or number plate on each lever shows its use and purpose; and,



to further distinguish the levers, all those operating switches may be painted one color, locking levers another color, and so on. Each hand-lever carries a spring-catch, which secures the lever at either end of the stroke; and the detent, forced down by the spring, and pulled up by the action of the signalman's hand in grasping the handle-end of the lever and its catch, instead of engaging in a notched rack, as on a locomotive, slides in a curved slot in a pivoted bar. This bar, or 'rocker,' is therefore moved about its pivot by the very action of the signalman grasping the lever. Interlocking virtually consists of mechanism attached to this pivoted bar, which renders it immovable under certain circumstances. These controlling circumstances are the positions of certain of the other levers in the frame. To exemplify this, we will take three levers, A, B, and C. If A and B be in such position that a signal given by the movement of lever C will be dangerous or misleading to a train, the pivoted bar connected to lever C is locked, and cannot be moved by any exertion of strength on the part of the signalman; and therefore he cannot even begin to move lever C, and the possibility of giving a wrong signal is put beyond doubt. Similarly, nothing is effected unless the lever completes its stroke. The pivoted bar or 'rocker,' through which the whole work of interlocking is done, moves only at the extreme ends of the stroke of the levers, and then is only moved by the rising or falling of the spring detent. This invention, simple as it seems, is the result of many years' experience, accidents having often occurred through a lazy signalman pulling his lever through part only of the stroke, and thus only partially effecting the locking. This is now impossible; and the *intention* of a switchman to move a lever, expressed by his grasping the lever and so moving the spring-catch, independently of his putting the intention into force, actuates all the necessary locking.

The details of locking-apparatus are somewhat complicated, but the principle is simple. Certain bars carrying lugs or projections are made to slide or move by the movements of the rockers. Certain other bars, which are also moved by the action of one or more rockers, are slotted or pierced with holes, so that, in certain positions, the lugs in the first set of bars can enter the holes in the second set of bars, and, in other positions, the lugs strike against the bars, and cannot be moved. It is, of course, obvious that the arrangement is such as to prevent unsafe or contradictory signals being given, and permit only of safe or harmonious signals; and, by a careful arrangement of the locking-apparatus, it is sometimes possible to make a few movements effect important changes of the switches and signals with a minimum of levers and complication.

It is obvious, that, when switches are worked from a distance, there is a chance of the switch being incompletely closed, owing either to dirt, or a stone, or ice, choking the switch itself, or the switch-rods working it. There is also a danger that the switch-rod might break or become disconnected, and that, though the signalman moved all his levers, and all the locking and unlocking was properly performed in his cabin, yet the switch itself might remain unshifted, or be left half open. To obviate this, the facing point lock was invented. This is a bolt which can only be shot into a crossbar connecting the two rails of the switch when the switch is either properly closed, or wide open. A failure of the switch connections, or an obstruction in the switch, will render it impossible for the bolt to enter the opening to lock the switch; and, as the signalman's lever actuating this lock interlocks with the signal levers, no train can be signalled to approach until the switch is either closed, or wide open, as the case may be, and firmly locked in its proper position. But another danger has to be guarded against: signalmen, to save time, will generally throw a signal again to danger directly the engine of an approaching train has passed; his other levers are then set free, and he can unlock his switch, and actually change the switch, before the whole train has passed, thus probably throwing the rear vehicles off the track, and causing a serious accident. To guard against this, a locking or detector bar is used, which lies near the rail, but clear of a wheel, when the switch is either shut or full open; but directly the switch is moved from either of these positions, the bar moves close to the tread of the rail, and takes such a position that it must come in contact with any wheel approaching the switch. As the bar is made longer than the distance between any two trucks, it follows, that, as long as a train is passing over the switch, one or more wheels of the train must prevent this bar being moved, and, as the switch-lock and the bar are arranged to move together, it follows that the switch cannot be unlocked until the last truck of the last car of a train has passed. The Union switch and signal company adheres to Saxby and Farmer's arrangement of this bar where it moves vertically. The Pennsylvania steel company shifts it laterally. The latter movement is more easily performed, and the bar can serve as a guard-rail; but its movement seems somewhat liable to be impeded by snow falling between the rail and bar.

(To be continued.)

THE WEATHER IN MAY, 1883.

THERE have been two periods of very severe storms, and at many places of tornadoes. The first of these accompanied a 'low,' first noted in Colorado[1] on the 13th. This moved with considerable energy over Colorado and Nebraska. On the 14th, increasing in energy,

[1] It has been found necessary, owing to the smallness of the appropriation, to give up all telegraphing reports west of the Rocky Mountains: hence the charts are made up only to the east.

MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, MAY, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF CHIEF SIGNAL-OFFICER.

it advanced into Ohio. At the morning observation of this date, pressures .5 to .6 inch below the mean were noted in Iowa.

Reports of hail on the 13th, 14th, and 15th, sometimes of astonishing size, have been sent from thirty-six stations, mostly in Iowa, Kansas, Missouri, Indiana, and Illinois. The following is a brief summary of tornado reports. Indiana: Amity, 14th, 7.30 P.M.; Waterloo, night of 14th, only three houses left standing; Muncie, night of 14th; Indianapolis, 14th, 6 P.M. In Kansas: Troy, 13th, 5 P.M.; Muncie, 13th, 4.30 P.M., most violent storm ever known in the county. In Michigan: White Pigeon, 14th, 4 P.M.; Sturgis, 14th, 3.30 P.M., came from south-east. In Missouri: Kansas City, 13th, 4.30 P.M., from south-west, track from a hundred and fifty to two hundred and fifty yards wide, damage $300,000; Cameron, 13th, 5 P.M.; Macon, 13th, 8 P.M.; Pattonsburg, 13th, 5 P.M. In Ohio: Fredrickstown, 14th, afternoon.

The second period was ushered in by a deep 'low' in Colorado on the 17th. At 11 P.M., Washington time, pressures at Yankton and North Platte were 29.16 inches, or more than .7 inch below the mean. On the 18th the 'low' moved into Minnesota, and on the 20th a portion of it moved east into the St. Lawrence valley; while its influence was felt in forming a second subsidiary 'low' in western Tennessee on the same date. The latter moved slowly, and passed off the Atlantic coast on the 24th. Tornadoes are reported as follows. In Arkansas: Eureka Springs, 18th; it cut a path a quarter of a mile wide through a dense forest, and destroyed several buildings. In Illinois: Hillsboro', 18th, 10 P.M., a funnel-shaped cloud moving north-east, the width of destruction, ten to thirty rods; Grafton, a car loaded with stone weighing twenty-one tons was lifted from the track, and the stones were scattered; Chemung, 18th, before 6 P.M.; Chicago, night of 18th; Springfield, 18th, 7.10 P.M.; Pesotum, 18th, 11.30 P.M.; Littleberry was nearly destroyed; Jacksonville, 18th evening, severest storm ever known; Edwardsville, 18th evening, came from south-east, width of track six hundred to eight hundred feet; Tallula, 18th, 9 P.M. Up to midnight of 19th, the number of deaths in Illinois caused by the tornadoes of this date was sixty-three. In Missouri: Moody, 18th, 19th, every house blown down; Berger, 18th, 7 P.M., six houses and one mill destroyed; Oronogo, 18th, 7.40 P.M., six persons killed, $75,000 damage. New York: 21st, one of the severest storms that ever visited Long Island. In Tennessee: Chattanooga, 20th, 4 P.M. In Wisconsin: Janesville, 18th evening; Racine, 18th, 7 P.M., twenty-five people killed, damage $60,000, track five hundred yards wide.

The chart of monthly isobars, isotherms, and wind-directions is given on p. 35. The permanent summer low-pressure area has enlarged a little, and moved only slightly from its position last month. Mean pressures are in general below the normal, except in Florida and the upper Missouri valley. The mean temperature east of the 100th meridian was 3.1° below the mean; highest temperature, 109° at Eagle Pass, Tex., and Yuma, Cal. Illinois and Missouri report damaging frosts on the 22d.

A comparison of floating ice with May, 1882, shows the eastern limit 3° west of last May, but the southern limit is the same. The number and size of icebergs are much less than last year, while there has been no field-ice. The Gulf of St. Lawrence, blocked last year, is clear this.

There were deficiencies in rainfall: Middle Atlantic, .58 inch; West Gulf, 1.50; Rio Grande valley, 2.93; extreme north-west, 1.65; and middle plateau, .69. Excesses: New England, 1.41; South Atlantic, 2.91; Tennessee, .54; Ohio valley, .77; lower lakes, 3.02; upper lakes, .85; upper Mississippi valley, .68; Missouri valley, 3.03; middle slope, 1.09; southern slope, 1.91; northern plateau, .99; North Pacific coast, .86; Middle Pacific coast, 2.33; and Southern Pacific coast, .80. In California the rain has been four times the usual May fall.

A hundred and thirty-nine cautionary signals were displayed, of which 84% were justified by winds of 25 miles or more per hour, at or within 100 miles of the station.

SYMMETRICAL LINEAR FIGURES PRODUCED BY REFLECTION ALONG A RIVER-BANK.

In July, 1882, I noticed on the Magaguidavic River, in New Brunswick, some figures, apparently formed through combination of actual fissures in the rocks at the water's edge, and the reflections of these fissures from the surface of the water, which were not a little remarkable.

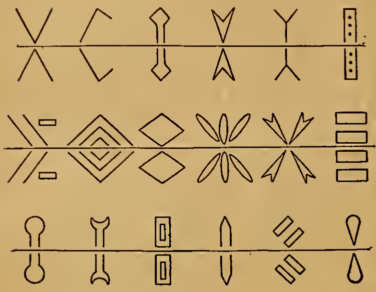
It was late in the afternoon. One thunder-shower had just ceased, and another was about to begin. The sky was somewhat overcast, and the water more or less shaded by the forest which covers most of the adjacent land. The banks of the river are bold, the shore being lined in many places with steep rocks having abrupt faces. Thanks to the lifting of the salt or brackish water by the tides, the boughs of the trees which overhang the river are trimmed off sharply and squarely, as if by shears, at a plane which marks the limit reached by the water of the highest tides. By the same means, the rocks on the strand are kept clear of vegetation; so that there is ordinarily a well-defined wall of bare rock between the water and the trees, even when the tide is high, and the river not far from being full. At the time I am speaking of, there was no wind: the surface of the water was absolutely glassy, and a superb reflection of the foliage of the forest was to be seen in the mirror which the river made. I had just remarked to a chance companion on our little steamboat how difficult it was to distinguish between the water and the land, so completely were the real rocks and trees blended with their reflections, when my attention was attracted by a rock, apparently at the water's edge, which was covered with symmetrical lines and figures. I called out to a friend, who was standing at some distance from me on the deck of the boat, to 'look at the pictured rock,' and, on turning from him to again look at the shore, I perceived that it was not one rock alone that bore figures: there was a long, broad ribbon or dado of similar picturing at the edge of the water, running along the shore between the real trees and the picture produced by the reflection of the trees in the water. I am fortunate in being able to say that my friend saw the picturing on the rock to which his attention was thus hastily directed, for the fact enables me to dismiss the notion that the figures might possibly have been 'subjective' to myself. I had, however, hardly time enough to get a fair view of the picture before a new shower of rain ruffled the water, hid the shore, and drove us under cover.

Beside herring-bone patterns, there were symmetrical lines, bars, and flutings of various lengths, together with figures suggesting short maces, staves, or even spears and arrows, as well as others in the semblance of hieroglyphics. Indeed, the whole effect was very Egyptian-like; while many of the lines recalled those so commonly used of late years for ornamenting furniture, — such lines as are, I believe, technically called 'reeding.'

On thinking the matter over, I was at first inclined to believe that I must have been looking into a great natural kaleidoscope; but, on further consideration and observation, it seems plain that simple reflection — that is to say, duplication by the water-mirror of lines, cracks, dents, or scars upon the rocks — might account for most, if not for all, the appearances I witnessed. I regret that the attitude of mere wonder and admiration into which my mind was thrown should have hindered me for the moment from making a proper critical examination of the figures; but I have been impressed by the conceptions that similar appearances cannot possibly be infrequent when the water of the river is still, and that some of the first rudiments of primitive art did probably originate in efforts made to copy such natural lineations as these.

There is, I believe, an old, perhaps it is an endless, dispute as to whether, in the history of human art, such kinds of ornamentation as herring-bone figures, reeding, and fluting have ever been derived from a direct imitation of natural objects, or whether they have not always arisen from mental conceptions. It has seemed to me that the observation here recorded should bear with considerable force in favor of the view of those students who refer the beginnings of all things to facts of actual observation and experience.

I am well aware that the atmospheric conditions were of somewhat exceptional character at the moment when I saw the picturing; but it is evident that rock-fissures, properly placed as regards a body of still water, will naturally be duplicated by reflection therefrom. There is every reason to suppose that figures analogous to those I witnessed may often be seen where rocks and water meet, and it is hard to believe that they have not been seen frequently by persons favorably situated. There is consequently no improbability in the idea that some of the primitive designs of savage nations may have been copied from them. Different effects would, of course, be produced in different localities, according to the quality and mode of stratification of the rocks, and to the nature of the jointings, seams, and scars which the rocks bear; and it is not unlikely that the rocks on the Magaguidavic River may be peculiarly well fitted for exhibiting these pictorial effects. But the capital fact of duplication by reflection must be common to all localities; and there are probably many places where ornamental figures would be produced by mere force of repetition even of very simple forms; that is to say, by the formation, at one and the same time, of a series of figures comprising many individual reflections, each one of which was similar to all the rest. A general idea of some kinds of forms that may possibly be seen where cracks in rocks are reflected from a body of calm water may be got by drawing figures like those of the diagram which I have selected from a hundred or more that occurred to me. No effort has been made in the diagram to copy the actual appearances seen on the river-bank.



An essentially different style of representation would be needed in order to convey a just conception of the effect of the scene I witnessed. With the exception of the herring-bone figure, I cannot profess that either of the figures of the diagram is like any of those I saw in New Brunswick. It is to be remembered, however, that, whatever the forms may be that are produced by reflection from one particular bank of rock, the same kinds of forms will usually and probably be repeated again and again with the result that a pattern or 'design' will be produced.

I consider myself so little qualified to look up a matter wholly foreign to my usual studies, that I have made no effort to search for records of observations similar to the one here described, though I am strongly inclined to believe that such records must exist. I would say merely, that on again steaming up the Magaguidavic River at a time when a breeze was stirring, and the surface of the water was ruffled, I saw none of the picturing excepting in one quiet nook or cove, where a series of really superb herring-bone figures was produced by reflection from the surface of the calm water of the lines of stratification between the beds of rock, which were here tilted at a considerable angle. Although during this second visit I saw none of the 'reeding,' or of the other kinds of symmetrical figures which had so much impressed me before, the multiplicity of the herring-bones, i.e., the continued repetition of this figure, was specially noteworthy. A peculiar kind of beauty or sense of satisfaction to the eye was thus obtained, which a single figure would clearly not have been competent to give. It is reasonable to suppose, that wherever complete herring-bone figures are formed, as here, by reflection of those lines between the layers of rock which are continuous, and, so to say, perfect, a variety of related or derived figures will be produced by the reflection of lines which are not continuous; that is to say, the reflections from lines that are imperfect in any way, or broken into various lengths, would give rise to hieroglyphic characters in considerable variety, though they might all belong to one common group or kind.

At the time of my second visit to the river, I could see no reason to doubt that the figures might be seen almost any day when the time of high tide, and consequently of a full river, happened to be coincident with the calm moments so common in summer at the hours not far from sunrise and sunset.

As bearing on the question of human imitation, it is of interest to note, that while herring-bone patterns would naturally be produced wherever the lines of stratification of tilted layers of rock are reflected from calm water, i.e., in numberless localities, it is precisely these figures which have been most frequently delineated by savages upon pottery and other implements as one of their earliest artistic efforts.

Excepting the two instances here recorded, I have never noticed any such figures in the course of my own travels, nor have I heard of their being seen by others. I am assured, moreover, by several of the most competent and experienced observers of my acquaintance, that they have never witnessed any thing similar. I expect, however, for my own part, to see such figures from this time forth, when opportunity offers, and I trust that many other persons will do so. It is to be hoped, withal, that some of the more noteworthy effects of this sort may be accurately depicted.

F. H. STORER.

THE AMERICAN SWAMP CYPRESS.

THE following observations on the bald or swamp cypress of the southern states are condensed from the forthcoming second volume of the memoirs of the Kentucky geological survey. They embody the results of certain inquiries which show that this peculiar tree deserves more study than has been given to it by our botanists.

The Taxodium distichum is, as is well known, a common tree in the swamps of the southern states, extending from New Jersey to Texas, and northwardly in the Mississippi valley, to the lowlands of southern Illinois. It has several titles to distinction: it is not only in all its proportions the noblest of all our coniferous trees east of the Rocky Mountains, vying in girth and height with the yellow poplar (the Liriodendron tulipifera of the botanists), but it is by far the most stately all the of trees belonging on the eastern face of the continent. Moreover, it has certain habits which are altogether peculiar to its species, and which constitute it a very exceptional member of the Coniferae.

When this tree grows on the dry ground, or on a surface where the water does not stand during the summer half of the year, it differs in no important feature from its kindred species; but, when it grows in swamps which are flooded during the spring or summer months, the roots form excrescences, which rise so that their crests overtop the level of the water during these seasons. These excrescences are of varying height, their projection above the level of the roots depending on the depth of the swamp-waters during those seasons of growth. These conditions may be satisfied by projections, or 'knees' as they are called, that rise only a few inches above the root, or they may rise to the height of five or six feet above the soil. These knees are sub-cylindrical in form; near the base they are elongated in the direction in which the root extends; above, they give a nearly circular section; at the top they are crowned by a cabbage-shaped expansion of bark of irregular shape, rough and warty without, often hollow within. They are often as much as eighteen inches in diameter. They are so commonly hollow, and of such size, that they are sometimes used by the natives for beehives or for well-buckets, for either of which uses they are tolerably well adapted. A tree of large size, say six feet in diameter, will often have as many as thirty or forty of these knees projecting above the swamp-water which surrounds its base.

Looking closely at these knees, we observe, that, unless they are evidently decayed, they generally have a very porous, spongy bark over the surface of their crests; and the bark on this summit, peeling off from time to time, often exposes a singularly spongy surface, such as we find in the inner bark of the pine-tree when the coarse outer bark is peeled away.

There have been many conjectures as to the function of these knees. It has been supposed that they were in the nature of suckers or branches from the roots, which gave rise to new trees; but, after examining thousands of these knees, I am convinced that they never have this nature. In no case have I seen or heard of any buds appearing on them. The only clew to their function I have obtained in the following way: whenever it happens that the knees become entirely submerged during the growing season, the trees to which they belong inevitably die. Very extensive proof of this point was given by the general submergence of extensive districts during the earthquakes of 1811–13, in the region near the Mississippi, where the cypress-trees over a region several hundred miles in area were killed by a subsidence that brought the water a foot or two below the crests of the knees. In Reel-Foot Lake, in Kentucky and Tennessee, thousands of these long ordinary cypress-boles still stand in the shallow waters, though it is now seventy years since they were killed by the slight submergence of their knees.

The same thing can be seen on a smaller scale in several mill-ponds in western Kentucky, where the change in level of the swamp-water has brought these excrescences below the surface of the water. These facts — viz., the absence of the knees when the tree grows on high land, and the death of the tree when the knees are permanently submerged — lead me to the opinion that the use of these excrescences is to bring the sap while in the roots in contact with the air. That they have this function is made more probable by the fact that their heads, i.e., the parts which always project above the water during the growing season, remain very vascular, and, by a process of desquamation, secure the exposure of the inner bark to the air.

It is evident that this tree affords us a very interesting instance of a specialized structure, that only develops when the plant occupies a certain position. We often find this tree artificially transplanted to the gardens of the western country. It then shows no distinct tendency to form knees, though the surface of the roots show a few short spurs not over an inch or so high.

It is a well-known fact that the genus Taxodium dates back into the early tertiaries. I am not aware, however, that fossil knees have ever been found. We have only to examine the borders of the swamps to see that it cannot, on the uplands, maintain a battle with the contending broad-leaved trees, though in any artificial open place it will grow with singular luxuriance.

It seems to me likely that we have here a very interesting case of a species owing its survival to a peculiar habit of growth. There can hardly be a doubt that the kindred of this Taxodium held an important place on the continent before the development of the broad-leaved trees. It seems not unlikely that it was crowded out on the higher ground, and forced to limit itself to this station which the swamps afford. In these permanent though shallow waters it clearly has an advantage over the broad-leaved forms of trees.

I am not aware that any structures resembling these knees are found among other plants. If it be the fact that they are peculiar to the Taxodium distichum, we have in this species a very remarkable case of a peculiar organ developed for a special purpose.

There is another interesting problem concerning this species. The seeds *seem* to germinate beneath the water. I have seen many young trees growing in what must be permanent swamp, where the soil was buried to the depth of a foot or more. I have long desired to try some experiments on this point, but have not been able to do so. I hope that some observer will undertake the inquiry.

This tree is certain to have a great economic value. Its great size, its favorable position in relation to our great water-courses, its very rapid growth and excellent timber qualities, are all calculated to commend it for use as a constructive wood. There are many million acres of land in the southern states where it could be cultivated to advantage. If kept from competition with the deciduous trees, it will do as well on any moist lowlands as in the actual swamps. Its growth is more rapid than that of any other of our timber-trees; the wood is said to be much stronger than that of any pine; it endures well in the open air without paint, as is shown by the fact that the trunks of trees killed in 1811 still stand undecayed in the swamps near the Mississippi River.

N. S. Shaler.

RECENT BABYLONIAN RESEARCH.

In the Proceedings of the Society of biblical archeology for November, 1882, Mr. T. G. Pinches, the Assyrian scholar of the British museum, reports a discovery of more than ordinary interest. This is an historical notice on an inscribed cylinder, coming from the ancient city of Sippar, and belonging to Nabonidus, the last of the native Babylonian kings. The cylinder was written before Cyrus had captured Babylon, but after his conquest of the Medes. The inscription of Nabonidus, after the usual introductory formulas, relates the reconstruction of several famous temples. The first of these, the temple of the Moon-god at Haran, had been destroyed by the Medes. Being instructed by the gods Marduk and Sin to rebuild it, Nabonidus recalls for this purpose his armies from Gaza, on the borders of Egypt. He informs us that the temple had once before been restored by the Assyrian king Assurbanipal (Sardanapalus), and that he found, while engaged in the work, the inscribed cylinders of Assurbanipal and of Shalmaneser II.

The great historic event referred to in this part of the inscription is the fall of the Median empire before Cyrus the Great. When commanded to restore the temple by the god Marduk, Nabonidus replies that the Medes have destroyed it, and receives from Marduk the promise that they in their turn shall also be destroyed. Nabonidus then relates: "At the beginning of the third year, they (the gods) caused them (literally 'him,' the Median nation) to go out to war; and Cyrus, king of the land Anzan, their (lit. 'his,' i.e., the Median nation's) young servant, overthrew with his small army the Median hosts, captured Astyages, king of the Medes, and carried him bound to his own (Cyrus's) land."

The undoubted value of this passage for the solution of the riddle left us by the conflicting testimony of the Greek writers, as to the relations of Cyrus and the Persians to Astyages and the Medes, is in part impaired by the ambiguous use of the pronouns. It is partly owing to this ambiguity that the translation just given differs from that of Mr. Pinches, who renders: "In the third year, he [the god Marduk] caused Cyrus, king of Anzan, his young servant, to go with his little army; he overthrew the wide-spreading Ṣabmanda [Medes], he captured Ištumegu (Astyages), king of Ṣabmanda, and took his treasures to his (own) land." It is difficult to say whether the words 'his servant' mean servant of Marduk, as Mr. Pinches supposes, or servant (= tributary) of the Median people; but the latter seems, for certain grammatical reasons, more probable. It is also improbable that Nabonidus, a special votary of Marduk, should speak of Cyrus, a foreigner, as a servant of the same deity, although we know that later, perhaps for state reasons, Cyrus was friendly to the worship of Marduk (V. Rawl. 35). It is more probable, that, when Nabonidus mentions Cyrus as 'his small servant,' he means to say that Cyrus was a vassal prince to the Medes. The translation 'him bound' (*kamûtsu*, lit. 'his bondage'), instead of 'his treasures,' is well established (I. Rawl. 13, 24 ff.), and adds not a little to the interest of the passage.

In the cuneiform annals of Cyrus, written after he had captured Babylon, we have this monarch's brief account of the war with Media (*Trans. soc. bibl. arch.*, vii. 155 f.). After a renewed careful collation of this important passage, Mr. Pinches has published the original a second time (*Proc. soc. bibl. arch.*, Nov., 1882). It is unfortunate that the ends of the lines are lost by mutilation of the clay tablet containing the inscription. Following is a translation of this passage: "[Astyages relied upon his troops] and marched against Cyrus, king of Anšan to [capture him?] . . . The troops of Astyages revolted against him, made him prisoner [and delivered him] to Cyrus . . . Cyrus (marched) to Ecbatana, the royal city. [He captured] the silver, gold, treasures (?), (and) possessions (?), which Ecbatana had gotten by plunder and he carried to Anšan the treasures and possessions which [he took?]." This version differs slightly from the one offered by Mr. Pinches, but not as to the revolt of the troops of Astyages, his delivery to Cyrus, and the capture of Ecbatana.

The accounts of Nabonidus and of Cyrus vary somewhat. The language of the former implies a battle in which Cyrus defeated the Medes and captured Astyages, but does not mention a revolt, nor the capture of Ecbatana, the Median capital. The account by Cyrus, being the state annals, is likely to be the more exact, and enters more into detail than that of Nabonidus; but the two are not at all contradictory. All that Nabonidus wished to record was the overthrow of the Median power and the capture of their king, and it was unimportant whether this took place in battle or by mutiny. It may be that he did not know the details of the war, or it is possible that one division of the Median army gave battle, while another mutinied and delivered Astyages to Cyrus. There is an apparent difference in the two accounts as to the date of the capture of Astyages. According to the Cyrus text, this event took place in the sixth year of Nabonidus, while Nabonidus says that it occurred in the 'third year.' It is, however, not clear from what point Nabonidus reckons, — perhaps from the date of his dream.

There is nothing in either of these accounts to show whether Cyrus was in any way connected by birth with Astyages. As to the relation of the countries of Media and Persia at this time, it is clear, from the language of Nabonidus, that Persia was a very small power; and if the word 'his servant' (*aradsu*), as applied to Cyrus, means the servant of the Medes, the conclusion would be that Cyrus was a tributary king to the Median power. This agrees with the statement of Herodotus (i. 107), that Cambyses, the father of Cyrus, was considered by Astyages as of respectable family, but inferior to an ordinary Mede. Nicolaus of Damascus also makes Persia subject to Media (Müller, *Frag. hist. Gr.*, iii. 399, Fr. 66).

It is certain that the mystery surrounding the relations of the Median and Persian courts and people can never be cleared up with the aids hitherto possessed. Nothing but the contemporaneous literature of these peoples themselves, and of neighboring peoples, can ever solve the problem. In another inscription Cyrus calls himself the king of Babylon, son of Cambyses king of Anšan, grandson of Cyrus king of Anšan, descendant of Šišpiš king of Anšan, royal offspring (V. Rawl. 35). This language is, however, not inconsistent with the tradition, so strongly represented by the Greeks, that the Persians were tributary to the Medes. To leave the government of subject nations in the hands of native kings was the rule in the later centuries of the Assyrian empire, and the Medes may well have practised the same policy. It was sufficient that the vassal king sent his yearly tribute, and, on proper occasion, kissed the foot of his master; but further than this was not required, and he was regarded as king in his own tribe or nation.

A word as to Anšan and Anzan. These are geographical terms, — the first a city; the second apparently a land, because preceded by the sign for a country. But since this sign often represents a city also, it may well be that Anšan and Anzan are only two different ways of writing the name of the same place. This seems to be also the opinion of Professor Sayce (*Trans. soc. bibl. arch.*, iii. 475). Probably there was both a city and a country Anšan, or Anzan. But what was Anšan? In the same inscription Cyrus calls himself king of Anšan and king of Persia (Parsu, *Trans. soc. bibl. arch.*, vii. 155, 159). Possibly Anšan, or Anzan, was originally the name of a tribe, city, and district, to which Cyrus and his family belonged.

Another temple which Nabonidus restores is the celebrated temple of the Sun-god at Sippar. Nebuchadnezzar, he relates, had restored this edifice, and had sought for cylinders, but without success. But Nabonidus was determined to find the inscription of the founder of the temple; and his search was rewarded, for, at a depth of eighteen cubits, he came across the cylinder of Naram-Sin, son of Sargon, which no king preceding him had seen for 'three thousand two hundred years.' According to the custom of the kings, he placed an inscription of his own by the side of that of Naram-Sin. As the date of Nabonidus was about 550 B.C., that of Naram-Sin would go back to 3750 B.C. But even at this time civilization must have been far advanced, for Sargon, the father of Naram-Sin (if the same as the Sargon of Agane), had in his library an astronomical work comprising seventy tablets. With this ancient date would agree the statement of Sargon II., king of Assyria 721-705 B.C., that three hundred and fifty princes had preceded him on the throne (Cylinder inscription, l. 45), and the long list of Babylonian kings, numbering, before the tablet was broken, two hundred or more.

A third temple, which Nabonidus restores, is that of the goddess Anunit at Sippar. By digging he found the inscription of the last king who had restored the temple, *Ṣaggašti-Buriaš*, son of *Kudûi-Bêl*, about 1050 B.C. Anunit, goddess of this temple, seems to be the planet Venus as morning and as evening star.

These two celebrated temples at Sippar are mentioned several times in the cuneiform literature. From Berosus, also, we know that the people of Sippar were devoted to the worship of the sun, for he calls the place 'city of the sun' (ἐν πόλει ἡλίου Σιππάροις). It was also, no doubt, as a part of this worship that the people of Sippar, whom the Assyrian king settled in the land of Samaria, burned their children in the fire (2 Kings, xvii. 31).

D. G. LYON.

OCEAN WATER AND BOTTOMS.

THE ocean explored by the Norske Nordhavs expedition, 1876–78, was a part of the North Atlantic lying to the west and north of Norway. The sea-water was especially studied in order to ascertain, if possible, whether the relation subsisting between its component parts varies sufficiently to admit of determining its fluctuations by the most exact analytical methods, and whether, in that case, it were possible to deduce some definite rule regarding them.

As the result of the analyses, L. Schmelck concludes, "The hypothesis which assumes the ocean to consist throughout its entire depth of one homogeneous fluid, in which the most accurate of chemical analyses shall fail to detect dissimilarity of composition, has received from the experiments here described probably stronger confirmation than from any that have gone before them." Some of the most interesting results are tabulated as follows, the first table showing the mean amounts of certain substances in sea-water at various depths, and the second showing the same for different parallels of latitude: —

I.

	Surface.	Bottom.	Intermediate depths.	Mean value.
Specific gravity	1.0265	1.0265	1.0266	1.0265
Chlorine	1.930	1.933	1.934	1.932
Calcium oxide	0.0576	0.0581	0.0577	0.0578
Magnesium oxide	0.2205	0.2207	0.2200	0.2203
Sulphuric oxide	0.2211	0.2208	0.2223	0.2214

II.

	80°–71°.	71°–66°.	66°–62°.
Specific gravity	1.0264	1.0265	1.0268
Chlorine	1.929	1.937	–
Calcium oxide	0.0580	0.0579	0.0577
Magnesium oxide	0.2190	0.2219	0.2205
Sulphuric oxide	0.2208	0.2210	0.2223

The mean value of the salts occurring in sea-water is given as follows: —

$CaCO_3$,	$CaSO_4$,	$MgSO_4$,	$MgCl_2$,	KCl,	$NaHCO_3$,	NCl.
0.002,	0.1395,	0.2071,	0.3561,	0.0747,	0.0166,	2.682.

Hence 100 parts of dry sea-salt contain —

$CaCO_3$,	$CaSO_4$,	$MgSO_4$,	$MgCl_2$,	KCl,	$NaCO_3$,	$NaCl$.
0.057,	4.00,	5.93,	10.20,	2.14,	0.475,	76.84.

The ocean-bottom studied is especially interesting from the amount of present and past volcanic and glacial activity in the lands surrounding it. Here, as elsewhere, depth was found to be the principal factor in determining the character of the deposits. Along the coasts of Norway and Spitzbergen, generally at a less depth than five hundred fathoms, the bottom was found to be covered with a more or less plastic gray clay. Its coarseness or fineness varies considerably; and grains of quartz, as a rule with rounded edges, constitute the chief portion of the mineral particles in it. At the approximate depth of from five hundred to a thousand fathoms, a brown clay is found, forming a transition from the gray clay to the true oceanic deposits.

At nearly all depths below a thousand fathoms, and oftentimes at less depths, is a fine light to dark brown colored deposit containing minute white shells of the genus Biloculina, in size and shape like a pin-head. This shell gives name to the clay, which corresponds approximately to the Globigerina ooze of the Challenger expedition. The ground is taken, that the power of sea-water to dissolve the carbonate of lime of the foraminiferal shells is not owing to the greater amount of carbonic acid at great depths in the ocean; for the observations of Mr. Tornøe showed that the sea-water invariably reacted as an alkali, and hence the carbonic acid could not be free. Again: the latter was found to be about the same in the depths of the ocean as on the surface; while the general uniformity of composition of the sea-water, as shown by numerous investigations, renders it improbable that any deviation in amount of carbonic acid occurs; hence the power possessed by sea-water to dissolve carbonate of lime does not depend upon the greater or less proportion of free carbonic acid.

The bottom of the shallow ocean between Norway, Beeren Eiland, Spitzbergen, and Novaia Zemlaia, was found to be covered with a greenish-gray clay containing but few animal remains. Minute and generally sharp-edged quartz grains were the principal constituent. This deposit was termed the Rhabdammina clay, from a genus of Foraminifera which often abounds in that part of the ocean-bed. This clay, according to Schmelck, originates from the 'decomposition of quartzitic rocks,' especially those of Beeren Eiland.

Off the volcanic island of Jan Mayen, above the six-hundred-fathom line, occurs a deposit of dark-gray sand, and sabulous clay containing fragments of basaltic lava, olivine, augite, etc., which seem to have been derived from the volcanic *débris* of the island.

An important fact bearing on the question of the distribution of *débris* by bottom-currents in the ocean is the statement that "all samples of water brought up from the bottom were perfectly clear, without a trace of floating particles."

The occurrence of numerous stones and pebbles on the sea-floor, as well as not uncommonly a rocky bottom, is of interest. The pebbles decrease in size and number in going from the shore towards deep water. While rare in the deep water south of the 72d parallel, they are quite common in that to the west of Spitzbergen and Beeren Eiland, where drift-ice abounds. Out of three hundred and seventy-five stations, pebbles and fragments of minerals and rocks were dredged at a hundred and twenty-three of them, while at many others no sample of the bottom could be obtained on account of its rocky condition. Of especial interest is the finding of numerous fragments of flint and chalk, a fossil (belemnite) from the chalk, fragments of coal, and some striated stones. Other pebbles and fragments found were marble, limestone, granite of various kinds, sandstone, argillite, quartzite, flint, chalk, granitic veinstone, quartz porphyry, gabbro, basalt, pumice, amygdaloidal rocks; chloritic, hornblendic, quartz, mica, and other crystalline schists; calcite, quartz, mica, hornblende, felspar, asbestos, coal, olivine, augite, coral, shells of various kinds, rotten wood, etc.

Schmelck concludes that organic agency is a subordinate factor in the formation of the floor-deposits of the northern ocean, as is volcanic *débris*, but that the chief portion of the material consists of the solid matter carried out to sea by drift-ice and glacial rivers. M. E. WADSWORTH.

THE NATURAL HISTORY OF IMPLEMENTS.[1]

"WHEN will hearing be like seeing?" says the Persian proverb. Words of description will never give the grasp that the mind takes through actual sight and handling of objects; and this is why, in fixing and forming ideas of civilization, a museum is so necessary. One understands the function of such a museum the better for knowing how the remarkable collection formed by Gen. Pitt-Rivers came into existence. About 1851 its collector, then Col. Lane Fox, was serving on a military sub-committee to examine improvements in small arms. In those days the British army was still armed (except special riflemen) with the old smooth-bore percussion musket, the well-known 'Brown Bess.' The improved weapons of continental armies had brought on the question of reform; but the task of this committee of juniors to press changes on the heads of the service was not an easy one, even when the Duke of Wellington, at last convinced by actual trial at the butts, decreed that he would have every man in the army armed with a rifle-musket. Col. Fox was no mere theorist, but a practical man, who knew what to do and how to do it; and his place in the history of the destructive machinery of war is marked by his having been the originator and first instructor of the School of musketry at Hythe. While engaged in this work of improving weapons, his experience led his thoughts into a new channel. It was forced upon him that stubbornly fixed military habit could not accept progress by leaps and bounds, only by small partial changes, an alteration of the form of the bullet here, then a slight change in the grooving of the barrel; and so on, till a succession of these small changes gradually transformed a weapon of low organization into a higher one, while the disappearance of the intermediate steps, as they were superseded, left apparent gaps in the stages of the invention, — gaps which those who had followed its actual course knew to have been really filled up by a series of intermediate stages. These stages Col. Lane Fox collected and arranged in their actual order of development, and thereupon there grew up in his mind the idea that such had been the general course of development of arts among mankind. He set himself to collect weapons and other implements till the walls of his house were covered from cellar to attic with series of spears, boomerangs, bows, and other instruments, so grouped as to show the probable history of their development. After a while this expanded far beyond the limits of a private collection, and grew into his museum. There the student may observe in the actual specimens the transitions by which the parrying-stick, used in Australia and elsewhere to ward off spears, must have passed into the shield. It is remarkable that one of the forms of shield which lasted on latest into modern times had not passed into a mere screen, but was still, so to speak, fenced with. This was the target carried by the Highland regiments in the low countries in 1747. In this museum, again, are shown the series of changes through which the rudest protection of the warrior by the hides of animals led on to elaborate suits of plate and chain armor. The principles which are true of the development of weapons are not less applicable to peaceful instruments, whose history is illustrated in this collection. It is seen how (as was pointed out by the late Carl Engel) the primitive stringed instrument was the hunter's bow, furnished afterwards with a gourd to strengthen the tone by resonance, till at last the hollow resonator came to be formed in the body of the instrument, as in the harp or violin. Thus the hookah or nargileh still keeps something of the shape of the cocoanut-shell, from which it was originally made, and is still called after (Persian, *nárjíl* = cocoanut). But why describe more of these lines of development when the very point of the argument is that verbal description fails to do them justice, and that really to understand them they ought to be followed in the series of actual specimens? All who have been initiated into the principle of development or modified sequence know how admirable a training the study of these tangible things is for the study of other branches of human history, where intermediate stages have more often disappeared, and therefore trained skill and judgment are the more needed to guide the imagination of the student in reconstructing the course along which art and science, morals and government, have moved since they began, and will continue to move in the future.

[1] Extract from a lecture on anthropology, delivered Feb. 21, at the University museum, Oxford, by E. B. TYLOR, D.C.L., F.R.S. From *Nature* of May 17.

THE INTELLIGENCE OF THE AMERICAN TURRET SPIDER.

AT the meeting of the Academy of natural sciences of Philadelphia, June 19, Rev. Henry C. McCook exhibited nests of Tarentula arenicola Scudder, — a species of ground spider of the family Lycosidae, properly known as the turret spider. The nests in natural site are surmounted by structures which quite closely resemble miniature old-fashioned chimneys composed of mud and crossed sticks, as seen in the log cabins of pioneer settlers. From half an inch to one inch of the tube projects above ground, while it extends straight downward twelve or more inches into the earth. The projecting portion, or turret, is in the form of a pentagon, more or less regular, and is built up of bits of grass, stalks of straw, small twigs, etc., laid across each other at the corners. The upper or projecting parts have a thin lining of silk. Taking its position just inside the watch-tower, the spider leaps out, and captures such insects as may come in its way. Nests had been found at the base of the Alleghany Mountains near Altoona, and in New Jersey on the seashore. In the latter location the animal had availed itself of the building-material at hand by forming the foundation of its watch-tower of little quartz pebbles, sometimes producing a structure of considerable beauty. In this sandy site the tube is preserved intact by a delicate secretion of silk, to which the particles of sand adhere. This secretion scarcely presents the character of a web-lining, but has sufficient consistency to hold aloft a frail cylinder of sand when it is carefully freed from its surroundings. A nest recently obtained from Vineland, N.J., furnished an interesting illustration of the power of these araneids to intelligently adapt themselves to varying surroundings, and to take advantage of circumstances with which they certainly could not have been previously familiar. In order to preserve the nest with a view to study the life-history of its occupant, the sod containing the tube had been carefully dug up, and the upper and lower openings plugged with cotton. Upon the arrival of the nest in Philadelphia, the plug guarding the entrance had been removed; but the other had been forgotten, and allowed to remain. The spider, which still inhabited the tube, immediately began removing the cotton at the lower portion, and cast some of it out. Guided, however, apparently by its sense of touch, to the knowledge that the soft fibres of the cotton would be an excellent material with which to line the tube, she speedily began putting it to that use, and had soon spread a soft smooth layer over the inner surface and around the opening. The nest in this condition was exhibited, and showed the interior to be padded for about four inches from the summit of the tower. The very manifest inference was drawn, that the spider must for the first time have come in contact with such a material as cotton, and had immediately utilized its new experience by substituting the soft fibre for the ordinary silken lining, or by adding it thereto.

LETTERS TO THE EDITOR.

Equations of third degree.

THE second or third terms of any equation may be made to disappear, and we may therefore assume

$$x^3 + Ax^2 + B = 0; \qquad (1)$$

and the solution of this equation must involve the general solution of cubics. Assume

$$x = y^{\frac{2}{3}} - y^{\frac{1}{3}}z^{\frac{1}{3}} + z^{\frac{2}{3}}. \qquad (2)$$

Hence

$$y^{\frac{1}{3}} = \sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{1}{2}z^{\frac{1}{3}}.$$

$$y = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{2}xz^{\frac{1}{3}} - z + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$y + z - \tfrac{3}{2}xz^{\frac{1}{3}} = \sqrt[\frac{3}{2}]{x - \tfrac{3}{4}z^{\frac{2}{3}}} + \tfrac{3}{4}z^{\frac{2}{3}}\sqrt{x - \tfrac{3}{4}z^{\frac{2}{3}}}.$$

$$z^{\frac{2}{3}} - \frac{y+z}{x}z^{\frac{1}{3}} = \frac{x^3 - (y+z)^2}{3x^2}.$$

$$z^{\frac{1}{3}} = \sqrt{\frac{4x^3 - (y+z)^2}{12x^2}} + \frac{y+z}{2x}.$$

$$z = \sqrt[\frac{3}{2}]{\frac{4x^3 - (y+z)^2}{12x^2} + \frac{y+z}{2} + \frac{3(y+z)^2}{4x^2}\sqrt{\frac{4x^3 - (y+z)^2}{12x^2}}}.$$

$$432x^6(z-y)^2 =$$
$$64x^9 + 240x^6(y+z)^2 + 192x^3(y+z)^4 - 64(y+z)^6.$$

$$x^9 - 3x^6(y+z)^2 + 3x^3(y+z)^4 - (y+z)^6 = -27zyx^6.$$

$$x^3 + 3\sqrt[3]{zy}\,x^2 - (y+z)^2 = 0. \qquad (3)$$

In (1) and (3), equating coefficients,

$$3\sqrt[3]{zy} = A, \quad zy = \frac{A^3}{27}. \qquad (4)$$

$$-(y+z)^2 = B, \quad y^2 + 2yz + z^2 = -B. \qquad (5)$$

Whence, from (4) and (5),

$$y = \sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$

$$z = \sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}.$$

Substituting these values of y and z in (2),

$$x = \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} + \sqrt{-\frac{B}{4} - \frac{A^3}{27}}} - \frac{A}{3} + \sqrt[\frac{2}{3}]{\sqrt{-\frac{B}{4}} - \sqrt{-\frac{B}{4} - \frac{A^3}{27}}}, \qquad \text{formula } (a)$$

or

$$x = -\sqrt[3]{\frac{B}{2} + \frac{A^3}{27} - \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}} - \frac{A}{3} - \sqrt[3]{\frac{B}{2} + \frac{A^3}{27} + \sqrt{\frac{B^2}{4} + \frac{A^3B}{27}}}. \qquad \text{formula } (b)$$

In the case of the irreducible case of formula (b), which is similar to Cardan's formula, formula (a) may be used. In such case, only one part, as $\sqrt{-\frac{B}{4}}$, of formula (a) is imaginary, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is real; and if the signs of the roots of equation (1) be changed, which is done by changing simultaneously the signs of A and B in equation (1), the converse is true, that is, $\sqrt{-\frac{B}{4}}$ is real, and $\sqrt{-\frac{B}{4} - \frac{A^3}{27}}$ is imaginary. Which shall be the imaginary term is, then, arbitrarily chosen. Hence, factoring preparatory to expansion by the binomial theorem, the coefficient of $\sqrt{-1}$ may be made less than unity when the real term is unity.

A. M. SAWIN.

Evansville, Wis.

Solar constant.

It is feared that the letter of Mr. Hazen (SCIENCE, i. 542) in relation to above topic may not entirely remove the confusion of which he justly complains. It should be premised that there are two units of heat in common use among physicists: the smaller being the quantity of heat required to raise the temperature of one gram of water 1° C.; the larger, the quantity of heat required to raise the temperature of one kilogram of water 1° C. The larger of these units is a thousand times as great as the smaller; and, in ordinary applications, no confusion is liable to arise. In either case, the number of units of heat received by the unit-mass of water is (sensibly) proportional to the number of degrees of rise of temperature.

With regard to the 'solar constant,' two additional units are required, — a unit of surface, and a unit of time. This constant may be defined in general terms to be the number of units of sun-heat incident perpendicularly on a unit-surface, in a unit of time, at the upper limit of the earth's atmosphere; or it is the number of degrees Centigrade a unit-mass of water would be raised in temperature by the sun-heat incident perpendicularly on a unit-surface, in a unit of time, at the upper limit of the atmosphere. The three units here indicated are, of course, arbitrary. But most physicists, following the example of Pouillet (*Comptes rendus*, vii. 24), take the gram, square centimetre, and minute, as respectively the units of mass, surface, and time. With regard to time, there is no diversity, the minute being universally used; but, for mass and surface, some employ the larger units of a kilogram and a square metre, and hence the apparent confusion. To obtain a general expression for the value of the 'solar constant,' let

Q = Quantity of sun-heat incident normally on a unit-surface in a unit of time = solar constant.
S = Area of surface receiving the heat.
T = Time of receiving the heat.
m = Unit mass of water.
n = Number of unit masses of water heated.
t° = Rise in temperature of the mass of water.

Then we have

$$Q \times S \times T = n \times m \times t^\circ.$$

Consequently, when S, T, and n are severally equal to unity, we have $Q = m \times t^\circ$; and, when $m = 1$, $Q = t^\circ$ = rise in temperature of a unit-mass of water = value of solar constant in units of heat.

Now, when the unit of time remains the same, but the units of mass and surface are changed, the value of t° (which measures the solar constant) will be altered, unless both of these units are changed in the same ratio. For, from the equation $Q = m \times t^\circ$, it follows that t° varies as $\frac{Q}{m}$; but evidently Q is proportional to the magnitude of the unit of surface: hence t° varies as $\frac{\text{unit of surface}}{\text{unit of mass of water}}$.

For example: using Pouillet's units, Langley's recent experiments make the solar constant = 2.84; that is, the sun-heat incident normally on one square centimetre, in one minute, at the upper limit of the atmosphere, would raise the temperature of one gram of water 2.84° C., or would heat 2.84 grams of water 1° C. Now, the unit remaining the same, if we assume the unit of mass to be one kilogram (1,000 grams), and the unit of surface to be one square metre (10,000 square centimetres), we should have the value of the constant $t'^\circ = \frac{10,000}{1,000} \times 2.84 = 28.4$ kilogram-units of heat; that is, the sun-heat incident normally on one square metre, in one minute, at the upper limit of the atmosphere, would raise the temperature of one kilogram of water 28.4° C., or would heat 28.4 kilograms of water 1° C.

Moreover, as it requires a definite number of units of heat to liquefy a unit-mass of ice, or to evaporate a unit-mass of water, or to produce a unit of mechanical energy, it follows that this constant may be measured by either of these units.

The exact determination of the value of this constant is a most refined and difficult experimental problem; for it involves the precise estimation of the amount of solar heat absorbed in traversing the earth's atmosphere, or the law of extinction of sun-heat in passing through it: hence it is, that, although several excellent physical experimenters have attacked the problem, their results are not so accordant as would be desirable. The following are some of the results: —

EXPERIMENTER.	DATE.	SOLAR CONSTANT.	
		Gram-units of heat per square centimetre per minute.	Kilogram-units of heat per square metre per minute.
Pouillet . .	1838	1.7633	17.633
Forbes . .	1842	2.847	28.47
Crova . . .	1876	2.323	23.23
Violle . . .	1876	2.540	25.40
Langley . .	1882	2.840	28.40

JOHN LECONTE.

Berkeley, Cal., June 25, 1883.

WARD'S DYNAMIC SOCIOLOGY.

Dynamic sociology, or applied social science, as based upon statical sociology and the less complex sciences. By LESTER F. WARD, A.M. 2 vols. New York, *Appleton*, 1883. 20+706; 7+690 p. 8°.

I.

THIS work of Mr. Ward is composed of two distinct parts. The first gives the outlines of his philosophy, as a basis for his reasoning in the one that follows. The second is a discussion of the causes and consequences of progress, or evolution, in human society. For some purposes it would have been wise to give each part a distinct title, reserving for the last part the one used; but the philosophic system propounded in the first part has evidently been prepared as a basis for the second, and in itself would not be considered by the author as a complete exhibit of his philosophy.

Vol. i. contains: first, an outline of the work, in which the author's purposes are clearly set forth; second, an historical review, chiefly devoted to a discussion of the philosophies of August Comte and Herbert Spencer; third, the cosmic principles underlying social phenomena, in which the outlines of the new system are set forth. Under the general title of 'primary aggregation,' he discusses the constitution of celestial bodies and chemical relations. Under that of 'secondary aggregation,' he discusses biology, psychology, and the genesis of man. Under that of 'tertiary aggregation,' he discusses the genesis of society and the characteristics of social organization. The purpose of this preliminary volume on general philosophy, and of the introduction to the second volume, is tersely given by Mr. Ward himself, as follows: —

"The purpose of the present chapter [chap. viii.], as already announced, has been to accomplish the complete orientation of the reader for the voyage before him. Without this, much that is to come might appear meaningless, or at least lose its point.

"Men think in systems. Most systematic treatises are unintelligible unless followed from the beginning and grasped in their entirety. A fundamental tone runs through them which prescribes the special sense of every line, and which is wholly unheard in isolated passages. The careful reader of such works, without necessarily acquiescing in the author's views, is able at least to comprehend them and to do justice to them." . . .

"In the following argument, now to be briefly stated, and subsequently to be fully elaborated, the statements made in this chapter, as well as those contained in the preceding volume, are to be taken as the basis, or premises, and must be granted 'for the sake of the argument' at least, however unsound they may be deemed in themselves."

Elsewhere the theory is more fully elaborated, that the more complex sciences can be grasped only as the more simple sciences upon which they are based are properly understood, and that anthropologic sciences in general must rest firmly upon physics and biology. Though the reader may differ from Mr. Ward in relation to his classification and conclusions, he will still be interested in the symmetry of his system and the perspicuity of his presentation.

The essential principle running through the treatise is, that progress in society is based upon the struggle for happiness in the same manner as biologic progress is based upon the struggle for existence. It is therefore a new system, in radical contrast with that taught in our schools and enunciated by the majority of publicists of the present day, of whom Herbert Spencer is the chief. For this struggle for happiness the term 'conation' (*conari*, to endeavor) is used, taken from Sir William Hamilton; and he says, "The term 'conation' will be employed in this work to represent the efforts which organisms put forth in seeking the satisfaction of their desires, and the ends thus sought will be designated as the 'ends of conation.'"

Again, the author classifies phenomena as *genetic* and *teleologic*. Genetic phenomena are such as appear in series, with natural antecedents and consequents, unaffected by design or purpose. Teleologic phenomena do not appear in natural series, the antecedents being physical phenomena controlled by design existing in mind, and the consequents being the purposes for which the will is exercised. Throughout the work these two classes of phenomena are clearly distinguished; but it is impossible, in a brief review, to set forth fully the importance of the distinction, as the author himself has done. In general terms, it may be stated that biologic progress is due to the struggle for existence, and involves genetic phenomena; while sociologic progress is due to the struggle for happiness (conation), and involves teleologic phenomena.

"All progress is brought about by *adaptation*. Whatever view we may take of the cause of progress, it must be the result of a correspondence between the organism and the changed environment. This, in its widest sense, is adaptation. But adaptation is of two kinds. One form of adaptation is *passive* or *consensual*, the other form is *active* or *previsional*. The former represents *natural* progress, the latter *artificial* progress. The former results in a *growth*, the latter in a *manufacture*. The one is the *genetic* process, the other the *teleological* process. In passive adaptation the means and the end are in immediate proximity, the variation takes place by infinitesimal differences; it is a process of *differentiation*. In active adaptation, on the contrary, the end is remote from the means; the latter are adjusted to secure the former by the exercise of *foresight*; it is a process of *calculation*."

By the term 'dynamic sociology,' as used by the author, is to be understood a systematic treatise on the forces which impel mankind into social relations, to develop social organization, and to provide and modify the institutions of society. The subject-matter of dynamic sociology, appearing in the second volume, is arranged in the following order, as set forth by the author: —

"The remainder of this work will chiefly consist in the discussion of six terms; and therefore, before entering upon such discussion, it is a primary necessity to furnish rigid definitions of each of these terms.

"For a purpose which will presently appear, we will assign to each of these terms a letter, which will fix their order in a series not admitting of any alteration.

"The first of these terms, which we will designate by the letter A, is *happiness;* the second, which we will designate by B, is *progress;* the third, which we will designate by C, is *dynamic action;* the fourth, which we will designate by D, is *dynamic opinion;* the fifth, which we will designate by E, is *knowledge;* and the sixth, which we will designate by F, is *education*.

"The definitions of these six terms are as follows:

"A. Happiness. — Excess of pleasure, or enjoyment, over pain, or discomfort.

"B. Progress. — Success in harmonizing natural phenomena with human advantage.

"C. Dynamic action. — Employment of the intellectual, inventive, or indirect method of conation.

"D. Dynamic opinion. — Correct views of the relations of man to the universe.

"E. Knowledge. — Acquaintance with the environment.

"F. Education. — Universal distribution of extant knowledge.

"Corresponding to these six terms thus defined, there are six theorems of dynamic sociology, which require to be elaborated and established, and to each of which a separate chapter will be devoted.

"Continuing the literal designations, these theorems are the following: —

"A. Happiness is the ultimate end of conation.

"B. Progress is the direct means to happiness; it is, therefore, the first proximate end of conation, or primary means to the ultimate end.

"C. Dynamic action is the direct means to progress; it is, therefore, the second proximate end of conation, or secondary means to the ultimate end.

"D. Dynamic opinion is the direct means to dynamic action; it is, therefore, the third proximate end of conation, or tertiary means to the ultimate end.

"E. Knowledge is the direct means to dynamic opinion; it is, therefore, the fourth proximate end of conation, or fourth means to the ultimate end.

"F. Education is the direct means to knowledge; it is, therefore, the fifth proximate end of conation, and is the fifth and initial means to the ultimate end."

The remaining six chapters of the work, namely, chapters ix., x., xi., xii., xiii., xiv., treat of these six subjects *seriatim*.

In chapter ix., then, the doctrine is set forth that happiness is the ultimate end of conation, or human endeavor. Here Mr. Ward discusses the nature and genesis of feeling, as the proper basis of a philosophic system involving the interests of man; and he subsequently endeavors to show, that, what function is to biology, feeling is to sociology. And after a discussion of the intellectual method as compared with the physical method of conation, and several collateral subjects, he sets forth the doctrine that degree of feeling is concomitant with degree of organization, and that the pursuit of happiness by man leads to higher physical, mental, and social organization; that, in turn, such higher organization increases feeling, and thus increases pleasure, and thus increases happiness.

Chapter x. is devoted to the consideration of progress as the primary means to happiness, and includes: a discussion of the difference between dynamic sociology and moral science; then a discussion of the growth of the means for communicating ideas, — language in all its forms; then of the arts and industries which are developed in the pursuit of subsistence; then the origin of government and the institutions of government; and, finally, the origin and institutions of religion.

Chapter xi. is entitled 'Action,' — a term chosen in preference to the more common expression, *conduct*. The chapter is chiefly devoted to the discussion of a systematic classification of actions, first, as involuntary and voluntary; and voluntary actions are again divided into impulsive or sensori-motor, and deliberative or ideo-motor. Each of the latter classes consists of two groups; namely, actions possessing moral quality, and actions devoid of moral quality.

It is no part of the author's purpose to treat of action possessing moral quality; although, in order to make clear the irrelevancy of such actions to his discussion, he occupies some space in going over the ground usually covered by writers on ethics. Actions devoid of moral quality are those upon which progress essentially depends, and chiefly that branch which falls under the more general head of deliberative or ideo-motor actions. They are further subdivided into static and dynamic, the former group embracing the great bulk of human activities in the performance of the ordinary duties of life. Static actions of this class do not result in progress, but tend simply to preserve the existing social status. Dynamic actions constitute the really progressive class of actions.

The chief fact which distinguishes dynamic actions from all others is, that they are performed by the indirect or inventive method. All the progress that has taken place in society has been due to such action. However spontaneous such progress may appear, it has, nevertheless, been the result of teleologic methods in adjusting natural phenomena in such a manner that they will accomplish desired ends, — remote in themselves, but foreseen by the intelligence of the developing intellect. The results are the essential elements of human art; and consequently civilization is fundamentally and wholly artificial. Here Mr. Ward introduces a series of illustrations of typical dynamic actions performed in the course of social progress, for the purpose of elucidating the central idea which he desires to embody in the term 'dynamic action.'

Chapter xii. is a discussion of opinion as the direct means to progressive action. As dynamic actions are ideo-motor, such actions must result from the possession by the agent of certain underlying and directing ideas. The truism that 'ideas rule the world' simply means, that opinions determine actions. But in order to produce dynamic actions, — that is, actions which will, in fact, result in progress, — it is essential that the opinions which underlie them be in rigid harmony with objective reality. Dynamic action can only flow from correct opinion.

Opinions must not only be correct, they must be important. Unless important, no appreciable dynamic result will flow therefrom. The most important opinions, or ideas, are arranged under four general heads: first, cosmologic ideas; second, biologic ideas; third, anthropologic ideas; fourth, sociologic ideas. Correct ideas belonging to these four great classes constitute the primary motive power to all human progress.

Chapter xiii. is upon knowledge, — the immediate data of ideas. Opinions cannot be directly reached. They are not subject to the will, either of the party holding them or of any other: they are simply consequents. Obviously, the antecedents of ideas consist in the data possessed by the mind relative to the materials and phenomena of nature. Such data are grouped by the author under the general term 'knowledge.' Knowledge, therefore, must first exist; and, if it exist, no effort need be expended in determining opinion. In this chapter the author shows that the chasm which in fact separates the intelligence of the lowest and the highest classes of mankind is chiefly due to inequality in the possession of the data for thought. He shows that the capacity of the mind is, in any particular class of society, practically equal; that, even in what are known as semi-civilized or barbaric races, the capacity exists for a far greater amount of knowledge than is ever obtained.

Chapter xiv. is on education as the direct means to knowledge. The possession of knowledge, therefore, if it could be secured, would constitute the true means to the proximate end, and thus secure the ultimate purpose. But the human mind is so constituted that it cannot be safely intrusted to secure this end for itself; for the individual cannot understand the necessity for this knowledge, or guide himself wisely in its attainment, prior to its acquisition: that is, the period of acquisition is in the earlier years of the life of the individual, when he must be guided by others. The initial means in the entire series is therefore education, actively considered as a function of society.

The work closes with a condensed but fundamental treatment of the general subject of popular education, in which appears a review of the various theories that have been held, and that still control human action on this subject. He divides the general body of public opinion into five parts, which he denominates 'the five kinds of education.' These are: first, education of experience; second, of discipline; third, of culture; fourth, of research; fifth, of information. The first four of these kinds of education are considered for the purpose of showing, that, however important in themselves, they are insufficient to accomplish the great end of securing an artificial civilization as the product of direct social action. The last of these forms of education, therefore, is the only one which embodies such promise.

The author sees little hope in the imperfect and desultory attempts of individuals to secure this great need in society. To render it of any value, he claims that education must be the systematic work of society in its organized capacity. Ceasing to exert itself longer in vain attempts to secure directly the various proximate ends, society should vigorously adopt this inital means, and concentrate its energies on the work which is clearly practicable, — that of furnishing to all its members the data actually in its possession.

Under the heading 'Matter of education' the author briefly, but without dogmatism, discusses the general theorem that the subject-matter should be a knowledge of nature, — a knowledge of the environment of the individual and of mankind. His treatment of the methods of popular instruction is brief, maintaining that this is merely a matter of supply in the politico-economic sense, which will certainly come as soon as there shall be an adequate demand. He says, "The methods and the teachers have always been as good as the popular notions of education, and they will doubtless continue to be so." The only criterion which he does lay down with regard to method is that it be teleologic. He insists that education, like every other department of civilization, must be an artificial product; that it must be undertaken deliberately, planned by human intelligence, and achieved through human effort.

The author discusses, in a broad and philosophic manner, a great body of questions in which civilized man is deeply interested. He has therefore written for a wide reading; and happily his style, in its essential characteristics, will not repel those to whom it is presented.

GEOLOGY OF SOUTHERN PENNSYLVANIA.

Second geological survey of Pennsylvania. — Report of progress T².— The geology of Bedford and Fulton counties. By J. J. STEVENSON. Harrisburg, *Survey*, 1882. 15+382 p., 2 maps. 8°.

PROFESSOR STEVENSON has made a detailed survey of the district, which has led to but few material changes in the map of the first survey. The descriptions of the structural geology are careful, plain, and easily understood; and the second part of the report, consisting of a day-book of observations along the roads, with reference to outcrops, mines, and quarries, will doubtless prove very useful.

It is well that Professor Stevenson has not completely neglected paleontology in his descriptions of the various formations; but this feature of his report is capable of much improvement, only about sixty species being cited as occurring in a section that extends from the upper coal-measures to the calciferous. The value of his determinations, and the scientific interest of his work, would have been much increased, if care had been taken to collect and determine the fossils found in each group, and lists of them published, together with the localities in which they occurred. It is not meant to infer that Professor Stevenson's determinations are incorrect, but simply that he gives no evidence in support of them. For instance: he says, "Some of these layers contain fossils which are *distinctly Chemung*, none whatever of Portage type being present; but, owing to the weathering, the forms can be identified only generically." The writer does not think he is alone in doubting whether there are any fossils which are distinctively Chemung. At any rate, it would be interesting to know what these genera are. He mentions no fossils in his Hudson River group, and in the Trenton mentions only three forms, which are also very common at the top of the lower Silurian. The director of the survey, in his letter of transmittal, makes the following curious remark, which seems to indicate a peculiar conception of the objects of paleontology. He says, "Paleontologists will find it an easy task to copy out from the index, separately, the whole list of fossil names, and arrange them afterwards to suit their own purposes." Certainly, paleontologists do not want to arrange fossils to suit themselves, but to find out how nature has arranged them. The two maps accompanying the report are of very indifferent quality, as it is difficult, especially over the Broad Top area, to follow on the maps the descriptions in the text. Mr. Stevenson disclaims responsibility for several things in them, which may account for the discrepancies between the text and the maps. Professor Lesley seems to think that the maps may be easily followed by a person familiar with the country; but the maps should have been constructed so that others, also, may be able to understand them. He seems to apply preconceived notions of orography, whether it agrees with the geology as studied in the field or not; and, if the responsibility of preparing the maps rested with the same person who has done the field-work and prepared the text, the result would probably be more intelligible. Mr. Stevenson mentions a bed 195 feet above the Pittsburg coal. This would apparently belong to the upper series, considered Permian in other reports of the survey; but this does not appear to be represented anywhere on the map.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Eclipses of Jupiter's satellites. — Cornu proposes to observe these eclipses photometrically, comparing the light of the satellite during the time while it is entering or emerging from the shadow with that of an artificial satellite visible in the same field, and made to vary in brightness at pleasure by an adjustable 'cat's eye,' so called. He shows that the moment when the light of the satellite is *half* that of its unobscured condition is the one which can be most accurately determined, and urges that the photometric observations should be so arranged as to give an automatic record. Admiral Mouchez has authorized the application of the necessary apparatus to one of the large equatorials of the Paris observatory.

M. Cornu does not seem to be aware that a very similar, but really more precise, method of observation has been in use at the Harvard college observatory for the past two years. Prof. Pickering, however, very wisely prefers to compare the eclipsing satellite with one of the other satellites, or with an image of the planet, rather than with an artificial star; and he uses polarization apparatus instead of a cat's eye to equalize the brightness of the objects compared. — (*Comptes rendus*, June 4.) C. A. Y. [40

MATHEMATICS.

Theory of functions. — In a series of three memoirs, M. Appell has reproduced in a more extended form a number of investigations which he has recently communicated to the French academy of sciences. The first of the three memoirs treats of uniform functions of an analytical point (x, y); the term 'analytical point' meaning simply the system of values of (x, y) formed by any arbitrary value of x and the, say, m corresponding values of y. The first section of the memoir contains three theorems concerning the development in rational fractions of such functions. In the second section a uniform function is defined, and also the poles and essential singular points (*points singuliers essentiels*, Weierstrass' *wesentliche singuläre stelle*). Functions with a finite number of singular points are then taken up, and a generalization of a known theorem concerning the coefficients in the development of a uniform function is given: viz., if $F(x, y)$ is a uniform function of the analytical point (x, y), having a finite number of singular points (a_i, b_i), and if R_i are the residues relatively to these points; if, further, in a certain region of the analytical point $\left(x = \infty, \ \lim \frac{y}{x} = C_k\right)$, we have $F(x, y) = \sum_{\nu=-\infty}^{\nu=\infty} A_\nu^{(k)} \frac{1}{x^\nu}$, — then we have the relation

$$A_1^{(1)} + A_1^{(2)} + \ldots + A_1^{(m)} = R_1 + R_2 + \ldots + R_n.$$

In this, i has all values from 1 up to n, and k has all values from 1 up to m; m denoting the number of values of y corresponding to a given value of x. After a brief review of some of the properties of the Abelian integrals, the author gives a generalization of a holomorphic function of x in the interior of a circle whose centre is a in terms of ascending powers of $(x - a)$. The subject of functions with an infinite number of singular points is then taken up, and a generalization is first given of Mittag-Zeffler's theorem concerning these functions; viz., if a series of distinct analytical points $(a_1, b_1) \ldots (a_\nu, b_\nu) \ldots$ are such that $\lim. (a_\nu, b_\nu) = (a\ b)$ for $\nu = \infty$, and if $F_1(x, y), F_2(x, y) \ldots F_\nu(x, y)$ is a series of rational functions of x and y which become infinite only in the two points (a_ν, b_ν) and (a, b) respectively, then there exists a uniform function $\Phi(x, y)$ having only the point (a, b) as an essential singular point, and admitting as poles the points (a_ν, b_ν) in such a manner that the difference $\Phi(x, y) - F_\nu(x, y)$ is regular in the point (a_ν, b_ν).

The second memoir by M. Appell is a continuation of the first. In it he considers the decomposition into prime factors of a uniform function of an analytical point (x, y) having only one essential singular point, and also gives a theory of doubly periodic functions with essential singular points. The author examines, first, functions having in a parallelogram of periods a finite number of singular points, and gives an interesting theorem; viz., the sum of the residues of $F(u)$ relative to the singular points situated in a given parallelogram of periods is equal to zero. A general expression is then obtained for a doubly periodic uniform function $F(u)$ having in a given parallelogram of periods only one singular point.

In the third memoir, M. Appell considers the development of functions in series inside an area bounded by arcs of circles. These three memoirs by M. Appell, taken with a memoir by M. Poincaré, which precedes them, and which has already been referred to in these pages, constitute a very valuable series of papers on the modern theory of functions. — (*Acta math.*, i. no. 2.) T. C. [41

PHYSICS.

Acoustics.

Upper limit of audibility. — Pauchon and Bertrand have investigated the question of the effect of the intensity of the sound upon this limit. A siren blown by steam with pressures varying from 0.5 to 1.5 atmospheres gave from 24,000 to 30,000 double vibrations as a limit; but, with certain modifications and a higher pressure (2½ atmospheres), the most acute sound that could be produced by the instrument, due to 36,000 vibrations, was still heard. Metallic rods of different lengths, set into longitudinal vibration in the usual manner, gave the following results: 1. The length of the rod giving the highest perceptible sound is independent of its diameter; 2. For steel, copper, and silver, the lengths are proportional to the velocity of sound in those media. These results disagree with those reached with the siren. The authors find, however, that, if the ear is aided by a resonating trumpet, the limit is slightly raised; that the limit is raised with substances like rosin, producing the most energetic friction; and that the sound, even when too high to affect the ear, still acts on a sensitive flame.

These results of Pauchon with the siren agree with the fact observed several years since by Dr. H. P. Bowditch of Boston, that, with a König's bar of exceedingly large diameter, the limit of audibility is higher than with one of the ordinary size. — (*Comptes rendus*, April 9.) C. R. C. [42

Production of whispered vowels. — Lefort calls attention to the wide range of whispered vowels that can be artificially produced by blowing across resonant tubes or spheres: *ou*, *o* (closed), *o* (open), *u*, *eu*, *e*, *i*, *é* (closed), *é* (open), — all being produced as the capacity of the resonator is diminished. By diminishing the length of an open tube the vowels *â*, *à*, *e*, *eu*, *u*, *è*, *é*, *i*, are successively heard, while *ou*, *ô*, *o*, are obtained by closing the upper end of the tube more or less. — (*Comptes rendus*, April 23.) C. R. C. [43

Transmission of sounds by gases. — Neyreneuf has studied the relative transmission of sound through air, carbonic oxide, carbonic acid, and illuminating-gas. The sound is transmitted through a tube two metres long, containing the gas experimented upon, and the intensity is studied by noticing the distance at which a sensitive flame ceases to be acted upon by it. He finds that air and carbonic oxide have the same transmissive power, air and illuminating-gas give very variable results, and carbonic acid has a much greater transmissive power than air. A table of results for air and carbonic acid is given. — (*Comptes rendus*, April 30.) C. R. C. [44

Experimental demonstration of velocity of sound. — Griveaux arranges a glass tube and a bar of pine wood of equal length, so that the passage of a pulse through either the column of air in the tube or the wooden rod shall move one of two light screws, and so break an electric contact. The current from a battery is divided, and passes into the two coils of a differential galvanometer; the light screw resting on the end of the rod being placed in one circuit, and a similar screw, resting on a membrane closing the end of the tube, in the other. The resistances are so arranged that the needle of the differential galvanometer remains normally undeflected. If a sound is produced by striking a drum, the needle of the galvanometer is deflected in such a direction as to show that the contact is broken by the movement of that screw resting on the end of the wooden rod, thus illustrating the greater velocity of the sound-wave in wood than in air. — (*Journ. phys.*, May.) C. R. C. [45

ENGINEERING.

Electric stop for steam-engines. — Mr. Tate, an English engineer, has combined the Leclanché battery, an electro-magnet, an auxiliary steam-cylinder, and a stop, to the closing of the stop-valve of the steam-engine, if its sudden stoppage should become necessary. It has been applied by Mr. Tate to the driving-engines of his large woollen-mills in Bradford. The mechanism consists of a weighted suspension rod attached to the stop-valve by a bracket, and actuated by a small steam-cylinder, the piston of which is supplied with steam through a valve which is opened by the action of the electro-magnet and the weighted rod. The movement of this auxiliary engine shuts the stop-valve of the engine in a small fraction of the time usually required to close it by hand. The wires of the battery are carried to various parts of the mill, so that the engine can be 'shut down' at any instant, and from any one of a number of promptly accessible points. This arrangement is proposed to be attached to the engines of steam-vessels, the wires being led to the bridge, and to other parts of the vessel where the officers can easily reach the button. — (*London times*, Oct. 21.) R. H. T. [46

Forms of steamers. — Two vessels recently built by the Messrs. J. & G. Thompson have been compared to determine their relative economy as a means of transportation as affected by a considerable difference in proportions. One was 390 feet long, 42 feet beam, and drew 18 feet of water: the second was 375 by 45 by 20 feet. The longer vessel had less fine ends than the broader ship. The former required 5,100-horse power to drive her 15 knots an hour, while the latter only demanded 3,900. At 13 knots, the power demanded was the same for both; but at higher speeds the difference became greater and greater, and more and more in favor of the shorter, broader, but finer ended vessel. The gain to be expected from giving ships greater beam, and, at the same time, finer ends, is expected to be observed in larger and faster vessels. — (*Mechanics*, May 26.) R. H. T. [47

Efficiency of the steam-engine. — Professor R. R. Werner, of the Technical high school at Darmstadt, publishes a paper describing his trial of a compound engine driving a mill in Augsburg. The engine has an indicated power of 132 horses. The cylinders have a proportion of 2.75 to 1; they are steam-jacketed, as is the intermediate reservoir; the ratio of expansion is 14. The boilers carry a pressure of about 7 atmospheres, and the steam supplied contains 3 per cent water. The steam-jackets condense about 11 per cent of the steam, and the cylinders demand about 7 kilograms (15.4 lbs.) of steam per horse-power and per hour, beside that condensed in the jackets. This is about the amount required as a minimum in the best-known English and American engines. In this country, a very similar figure has been reached by Corliss and by Leavitt. — (*Zeitschr. ver. deutsch. ing.*, May.) R. H. T. [48

'Compound' locomotives. — M. Mallet communicates to the French society of engineers a note from M. Borodine, giving the results of experiments to determine the relative economy of the simple and the compound system of engine for locomotives. The engines experimented with were those designed for the railway from Bayonne to Biarritz by M. Mallet. The trials extended over a considerable period of time, and the comparisons were made fairly complete. The result showed the compound system to have an economy of from ten to twenty per cent, according to the conditions under which they are carried out. The variation in the ratio of expansion is very greatly restricted in the compound engine. The use of the steam-jackets with which the engines were provided did not prove to be of advantage. The expenditure of steam was greater when they were in use than when they were shut off. — (*Mem. soc. ing. civ.*) R. H. T. [49

CHEMISTRY.

(Organic.)

Compounds of benzotrichloride with phenols and phenylamines. — When a mixture of one molecule of benzotrichloride and two molecules of phenol is heated gently, O. Döbner finds that the following reaction takes place: —

$$C_6H_5CCl_3 + 2C_6H_5OH = C_6H_5CCl\begin{matrix} C_6H_4OH \\ C_6H_4OH \end{matrix} + 2HCl.$$

The remaining chlorine atom is replaced by a hydroxyl group when the product is heated with water, forming dioxytriphenylcarbinol, —

$$\begin{matrix} (OH) \\ C_6H_5 \end{matrix} C \begin{matrix} C_6H_5OH \\ C_6H_5OH \end{matrix}.$$

By reduction, dioxytriphenylmethan

$$\left(\begin{matrix}H & & C_6H_5OH\\ & C & \\ C_6H_5 & & C_6H_5OH\end{matrix}\right)$$

is formed. An analogous reaction takes place if resorcine is used instead of phenol. The resulting resorcine benzein, by reduction, gives tetraoxytriphenylmethan, —

$$C_6H_5CH\ CH\begin{matrix}C_6H_3(OH)_2\\ C_6H_3(OH)_2\end{matrix}.$$

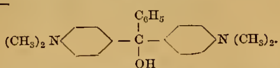
With primary aromatic amines, benzotrichloride united readily. When added to a mixture of dimethylaniline and zinc chloride, it formed malachite green, —

$$\begin{matrix}(OH) & & C_6H_4N(CH_3)_2\\ & C & \\ C_6H_5 & & C_6H_4N(CH_3)_2\end{matrix}.$$

By reduction, this substance gave the corresponding leuko-base, —

$$\begin{matrix}H & & C_6H_4N(CH_3)_2\\ & C & \\ C_6H_5 & & C_6H_4N(CH_3)_2\end{matrix}.$$

The base malachite green was easily decomposed, when heated with hydrochloric acid, into dimethylamine and benzoyldimethylaniline. This reaction points to the following structure for malachite green: —



The action of benzoyl trichloride upon hydroxyl or amido compounds seems, therefore, to be normal to the para position with respect to the amido or the hydroxyl group. — (*Ann. chem.*, ccxvii. 223.) C. F. M. [50

GEOLOGY.

Lithology.

The Potsdam and St. Peters sandstones. — The surface induration of the friable Potsdam and St. Peters sandstones, as determined by macroscopic observations in 1871–73, was brought to the notice of the readers of SCIENCE some time ago (i. 146), while a recent interesting paper by Prof. R. D. Irving gives the results of his microscopic investigations on the same subject. Irving finds, as Sorby had previously, that ordinary quartz grains, formerly rounded and worn, have been built out and supplied with crystal facets from silica deposited later on them. He finds that the induration of the above-mentioned sandstones arises from the deposition of interstitial quartz cementing the grains. The deposited quartz is found to be optically oriented, the same as the enclosed grain, which is distinguished by its cloudiness and worn surface, and frequently by a coating of oxide of iron upon it.

To the deposition of quartz upon worn quartz grains is ascribed the occurrence of quartz crystals in the Potsdam sandstone described in 1882 by Rev. A. A. Young. Credit should have been given by both Irving and Young to Rev. John Murrish for calling attention to the occurrence of quartz crystals in Potsdam sandstone in 1870–72 (*Bull. Wisc. acad.*, ii. 32), especially since Murrish's observations were discredited at the time.

All quartz crystals in sandstone have not this derivation, as the writer showed for the Lake Superior sandstone in 1880, the crystals of which come from old eruptive rocks owing to the decomposition of the matrix. It is pleasant to find my earlier observations on the surface induration of the Wisconsin sandstones, and the formation in them of quartz crystals, sustained by the much more complete and valuable work of Irving, made, as his was, without any knowledge of mine.

Irving holds that the quartz deposited may come from the action of water on the occasional felspar particles in the rock, although sometimes from an external source. He further regards the induration of quartzites and quartz schists as caused by the same deposition of intersticial quartz. — (*Amer. journ. sc.*, xxv. 401.) M. E. W. [51

Antase as an alteration product of titanite. — The titanite in a biotite amphibole granite from the Troad was found by Mr. J. S. Diller to be replaced by a light wine-yellow to honey-yellow mineral, showing, under the microscope, quadratic and rhombic sections. The former are isotropic, and have a well-marked cleavage parallel to their sides; the latter are strongly doubly refracting, extinguish parallel to the diagonal, and have one cleavage parallel to the short diagonal and another to the edges. In order to isolate the substance, the finely pulverized rock was separated into two portions, one of lighter and the other of heavier specific gravity than 2.72, by means of the potassium-iodine-mercury solution. The yellow mineral was found in the second portion, which contained also iron ore, zircon, and apatite. The ore was removed by the electro-magnet, and the apatite by nitric acid. By means of the cadmium-boron-tungstate solution it was shown that the yellow mineral had a specific gravity between 3.6 and 4.5. Some grains were picked out, and found to be insoluble in hot aqua regia.

The mixed zircon and yellow mineral powder gave a reaction for titanium, while the pure zircon would not: hence it was inferred that the mineral contained titanium. Its angles were found to be 98° 24′ and 136° 16′, while the corresponding ones of antase are 97° 51′ and 136° 36′. From its optical, chemical, and crystallographic characters, it was then inferred that the yellow mineral was antase. — (*Neues jahrb. miner.*, 1883.) M. E. W. [52

GEOGRAPHY.

(*South America.*)

The Puno railroad, Peru. — Dr. R. Copeland gives a readable account of a journey over this remarkable railroad from its beginning at Mollendo on the coast, through Arequipa, to Puno on Lake Titicaca, and of his farther travels by boat on the lake, and by stage, beyond to La Paz in Bolivia. The features that attracted his special attention were the deep, narrow valleys followed by the road in its sharp windings while ascending from one pampa level to the next; the broad, flat, barren pampas at great and greater altitudes; and the superb views of the volcanic peaks and ranges of the Cordillera, — Misti, Chaycam, and Pichupichu, eighteen to nineteen thousand feet in height. On the pampa of La Joya (4,100 feet) he saw countless hillocks of pure, sharp sand (*médanos*), in half-moon form, with the curve to the west or windward (see SCIENCE, i. 488). A mirage gave these white hills the appearance of drift-ice in an arctic sea. — (*Deutsch. geogr. blätter*, vi. 1883, 105.) W. M. D. [53

Colombia. — R. B. White, for several years resident in Colombia, and a companion of Stübel and Reiss in some of their expeditions, furnishes a summary account of the more attractive parts of this republic, and of its productions, and chance of development. Several of the rivers that flow northward between parallel ranges of the Cordillera are navigable for small steamers for many miles into the interior, opening districts well adapted to agriculture, and well supplied with timber and mineral products. Above the low plains the climate is healthy. A good share of the world's platinum supply is obtained from the upper valley of the San Juan, and gold occurs in profitable quantity in many of the river-gravels. Brief mention is made of an ascent of the snowy volcano, Puracé; and the extensive view from the Cerro Munchique, nearly ten thousand feet high, west of Popayan, is highly praised. The geological observations on the origin of mountain and valley form do not carry conviction, and the frequent mention of volcanic upheaval and valleys of fracture remind one of the theories of fifty years ago. — (*Proc. roy. geogr. soc.*, v. 1883, 249.) W. M. D. [54

(*Africa.*)

The Kongo. — Dr. Pechuel-Loesche, a member of the German-African expedition to Loango in 1873–76, and later in charge at Stanley Pool while Stanley went to Europe, recently read an address on the Kongo and the neighboring mountains of western Africa before the German geographical congress at Frankfort. The river is remarkable for the rapids all along its course, and especially in its narrow passage through the mountains below Stanley Pool, where it falls nine hundred and twenty-eight feet in some three hundred and forty miles. Of the several falls in this part of its course, only one is vertical, that of Isangila, with a height of sixteen feet. There are two periods of high water, with a rise of twenty feet, when the falls disappear in a uniform rushing flow. The water rises from September to January, falls from January to March, attains its greatest height in the rainy months (April and May), and its lowest level in July and August. Many of the mountain brooks have cut deep channels, and join the main stream on a level; but some of the larger rivers of the interior, flowing over horizontal rocks, have not cut their way so deeply, and, on joining the Kongo, form cataracts. Thus the Luenga falls three hundred feet, and the Luvubi five hundred feet. (This, if correctly reported, is certainly a very abnormal arrangement.) The mountain belt is about two hundred miles wide, rising from a sloping plain at about one thousand feet to rounded and monotonous elevations with a maximum of three thousand feet. The higher land is grassy, with small trees and apparently leafless bushes: the more luxuriant growth of lofty trees and palms is hidden in the valleys. It is these deep and steep-sided valleys that make the rather open upland difficult to traverse. Near the river, the natives have destroyed all the forest-trees, either by burning or cutting. The villages are built on high and bare summits. Dr. Pechuel-Loesche regarded the Makoko (ruler of the stream), with whom de Brazza had made a treaty two years ago (SCIENCE, i. 79), as a local ruler of no general authority. The Makoko's son had reported that his father had ceded no land to de Brazza, and that he had no French flag in his possession. There are four Makokos in this region; and none of them has a right of precedence over the others, or any title to be sovereign of the Bateke population of this part of the Kongo. — (*Proc. roy. geogr. soc.*, v. 1883, 286.) W. M. D. [55

The muatiamvo of the southern Kongo basin. — Max Buchner, the fourth European who has been in this region in the last two centuries, spent half a year at the residence of the 'muatiamvo,' or king (SCIENCE, i. 19), and reports on the peculiar form of his government. The kingdom on the southern side of the Kongo basin, the special field of the German-African explorations, includes an area about as large as Germany. Its population can hardly exceed two millions, and its power cannot compare with that of Mtesa's country, farther east, where an army of a hundred thousand men can take the field. Here the army is not more than one thousand strong at the highest; and Buchner says he could go where he chose with fifty European soldiers, if they were not attacked by that more dreaded enemy, the African fever. And yet, through a large part of south-western Africa, the muatiamvo is the greatest native power. The most notable peculiarity of the government consists in the presence of a second high authority besides the muatiamvo, namely, the 'lukokessa,' or queen: she is not the wife of the king, who has some sixty wives of his own, but is free and independent of him, having her own chief consort, the 'shamoana,' and numerous frequently changing husbands of lower order. Buchner traces the origin of this form of government, and gives a list of thirteen muatiamvos, down to Shanana or Naoesh-a-kat, the present king, and describes the different parts of the kingdom and its neighboring states. — (*Deutsche geogr. blätter.*, vi. 1883, 56.) W. M. D. [56

BOTANY.

Pollination of Rutaceae. — Urban has studied the adaptations for fertilization in a considerable number of species of this heterogeneous order, using living material at the Berlin botanic garden. As few of the genera have been previously studied in this respect, a rather full translation of his tabulated summary is given.

I. MONOCLINOUS SPECIES.

A. *With dichogamous (protandrous) flowers.*

1. Nutation successively places the dehiscent anthers at the point which the receptive stigma occupies later.

a. Style undeveloped in the staminate stage.

α. The filaments rise from their original horizontal position, place themselves against the ovary, resume their original position, and again become erect, but without lengthening; petals plane; self-pollination usually impossible: *Ruta.*

β. The originally short, erect filaments lengthen, curve inwards, and again straighten; petals united below in a tube; close pollination possible by gravitation: *Coleonema.*

b. Style developed in the staminate stage, though not always to its full length; so placed as to oppose self-pollination.

∸ Flowers zygomorphic.

α. The stamens which lie on the lower lip successively bend upward, and, after dehiscence, resume their original position; the end of the style likewise bends up at maturity: *Dictamnus.*

β. The stamens, originally bent upwards, successively straighten at maturity, then bend outward; the style, bent downward when young, straightens when the stigma becomes receptive: *Calodendron.*

≐ Flowers actinomorphic. The filaments successively elongate after dehiscence.

α. In the staminate stage the style is bent horizontally across the ovary; the stamens bend over the pistil successively at maturity, then lengthen, and turn outward between the finally erect petals: *Diosma tenuifolia.*

β. Similar to the last; but the staminodia, and not the petals, become erect, the stamens bending outward but little: *Adenandra.*

γ. After flowering, the style bends outward and downward between the staminodia, the petals remain horizontal, the staminodia lie against the ovary, and, after dehiscence, the fertile stamens resume their original horizontal position: *Barosma.*

2. The stamens nutate but once, and simultaneously. In the staminate stage they are perpendicular, or incline but little toward each other, so that the anthers are in contact at their margin; in the pistillate stage they have bent outward.

a. The anthers fall away when the filaments curve outward: *Ravenia.*

b. Anthers persistent on the bent filaments.

∸ Pollen may fall on the unreceptive stigma, and so effect self-fertilization. Even later this is not impossible, as the wind or gravitation may carry pollen from the reflexed stamens to the mature stigma.

α. In the pistillate stage the style elongates: *Zieria* and *Eriostemon.*

β. With normally developed stigma: *Boronia* (ex parte).

γ. When the style lengthens, the stigma may encounter the anthers of the still erect stamens: *Erythrochiton.*

≐ The viscidity of the pollen, and the situation of the anthers, prevent self-pollination: *Metrodorea.*

3. The stamens do not nutate at all.

a. Self-pollination possible in the pendant flowers after the separation of the lobes of the stigma: *Correa.*

b. The style is surrounded by staminodia in the first stage; in the second stage spontaneous pollination by neighboring flowers may occur if insect-crossing has not been effected: *Agathosma* (ex parte).

B. *With synacmic flowers.*

1. Self-fertilization impossible.

a. With viscid pollen: *Boronia* (ex parte).

b. The stigma surpassing the anthers: *Triphasia.*

2. Spontaneous self-pollination impossible because of the situation of the filaments, but spontaneous crossing between neighboring flowers favored: *Agathosma* (ex parte).

3. Spontaneous pollination of either sort opposed; crossing by insects inevitable: *Crowea.*

4. Spontaneous close fertilization possible; crossing favored: *Cusparia, Choisya, Skimmia* (ex parte), *Murraya, Citrus.*

II. DICLINOUS SPECIES.

Self-fertilization impossible; crossing necessary: *Ptelea, Skimmia* (ex parte). — (*Jahrbuch bot. gart. Berlin,* ii.) W. T. [57

ZOÖLOGY.

Mollusks.

Credit to an American naturalist. — In an official report by M. Bouchen-Brandely, secretary of the college of France, the author states that he has learned by two years of study that the sexes of the Portuguese oyster are confined to separate individuals ; that after this discovery he conceived that it might be possible to artificially fertilize the eggs of this mollusk ; and that, after two years more of experimenting, this attempt has been successful. Americans will be interested to learn that in 1879 an American naval officer, Lieut. Francis Winslow, who was stationed at Gibraltar for a few weeks, determined the unisexuality of the Portuguese oyster, and reared it from artificially fertilized eggs. His results were printed in the *American naturalist* in 1879 or 1880 ; but, as I have no opportunity for reference at present, I cannot give the exact date. — W. K. B. [58

Notes. — In the year-book of the Verein für vaterländische naturkunde in Württemberg, published lately at Stuttgart, Weinland has a paper on the mollusk fauna of the Württembergisch Franken, and Wundt one on the zone of Ammonites transversarius in the Suabian white Jura. —— The second part of the *Quarterly journal of microscopical science* contains a paper by Lankester on the existence of Spengel's olfactory organ and of paired genital ducts in Nautilus pompilius. —— Heude's 'Conchyliologie fluviatile' of Nanking and Central China approaches completion. The ninth and concluding fasciculus will appear during the present year. It is luxuriously illustrated, and printed in large quarto. —— Kuster's continuation of Martini and Chemnitz Conchylien cabinet bids fair to go on, like Tennyson's brook, forever. Lieferung 322 is announced. This work would be much benefited by the total exclusion of the frightful engravings which illustrated the earlier editions and are still pressed into the service. —— J. B. Gassiés, known by his conchological researches in New Caledonia and Southern France, has recently died. — W. H. D. [59

Insects.

American paleozoic insects. — R. D. Lacoe, whose collection of these objects must be one of the largest, if not the largest, in the country, has prepared a list of those hitherto published, including twenty-six genera and forty-eight species of hexapods, five genera and species of arachnids, and nine genera and nineteen species of myriapods, — a total of forty genera and seventy-two species. This embraces, however, three genera and fourteen species still unpublished. The list is purely bibliographical, excepting that it contains careful statements of the place of discovery of the fossils, the name of the finder, and the place of present deposit. About half of the described species have been published within the last five years. — (*Wyom. hist. geol. soc., publ.* 5.) [60

A monstrous caterpillar. — E. H. Jones figures a curious larva of the geometrid moth Melanippe montanata of Europe, which he exhibited at an entomological reunion at the Royal aquarium on March 5. It has the antennae and legs of the perfect insect fully developed, while in other respects a normal larva. It was reared from the egg with a dozen others. Last November this one, then normal, was considerably larger than the rest of the brood,

Abnormal larva of *Melanippe montanata.*

and was noticed as a constant feeder. "On Feb. 15 I was astonished to find that this forward individual had developed the antennae of the imago, but without in any other way altering its larval appearance. For a space of two or three days the antennae were beautifully pectinated, and then the prolegs [thoracic legs ?] of the imago became perfect. . . . Both antennae and legs then gradually shrank and dried until the 20th." — (*Entom.*, xvi. 121.) [61

VERTEBRATES.

Temperature and pulse rate. — By means of his new method of isolating the mammalian heart, Prof. Martin has been able to make an accurate study of the effect of variations of temperature on the rate of beat of the dog's heart when completely separated physiologically from all the rest of the body except the lungs. In the brief abstract of his work which has been published, a short description of the method of operating is given, together with some of the more important results which have been obtained. He finds that in the mammalian heart, as in that of the frog, the rate of beat is gradually increased as the temperature of the blood is raised from 27° to 42° C. The quick pulse of fever can therefore be explained by the direct action of the heated blood on the heart itself, without assuming any special action upon the extrinsic inhibitory or accelerator nerve-centres.

The rate of beat of the heart is found to bear a much more direct relation to the temperature of the blood in the coronary arteries than to the temperature of the blood in the right auricle or ventricle.

An interesting point which comes out of the method of work is, that, although the defibrinated calf's blood used to nourish the heart was repeatedly circulated through the heart and lungs for several hours, it gave no evidence of clotting at the end of an experiment, showing that fibrinogen is not formed in these organs. — (*Proc. roy. soc.*, no. 223, 1883.) W. H. H. [62

Lymphatics of periosteum. — George Hoggan and Frances Hoggan criticise the previous writings on this subject, and give the results of their own studies. They assert that what Budge described as the lymphatics are really capillary blood-vessels. Their own conclusions they summarize as follows : —

1. The lymphatics of the periosteum exist only on the outer surface, or within the outer gelatinous (white fibrous) stratum of the membrane. They never ramify upon the inner or bony surface. 2. When the periosteum is thin, more especially when the animal is old, the whole lymphatic plexus lies free upon the outer surface; but when the periosteum is thick, lymphatic twigs may pass part way through, but they never reach the inner surface. 3. The lymphatics accompany the blood-vessels, as if arranged to drain them. 4. No lymphatics exist on the surface of the great cavities of the bone. "There is thus every reason to believe that the lymphatics never come in contact with the bone itself, and that bone possesses no lymphatics apart from those found within the periosteum, which may be physiologically considered, therefore, as the lymphatics of bone." — (*Journ. anat. physiol.*, xvii. 308.) C. S. M. [63

Fish.

Classification of the Petromyzontids. — The Lampreys have been systematically considered by Gill, and are differentiated into two sub-families: 1. The Petromyzontinae, 'with the suproral lamina median and undivided;' and 2. The Caragolinae, 'with two lateral suproral laminae.' The former embraces six genera, one of which is named for the first time Exomegas, and is intended for the Petromyzon macrostomus of Buenos Aires: the Caragolinae are confined to the southern hemisphere; i.e., Australia and Pacific South America. — (*Proc. U. S. nat. mus.*, iv. 521.) [64

Characters of the Ephippiids. — The family of Ephippiids is distinguished by T. Gill from the Chaetodontids by the bifurcation of the post-temporal bones, and the wide, scaly isthmus extending from the pectoral region to the chin, and separating the branchial apertures.—(*Proc. U. S. nat. mus.*, iv. 557.) [65

Extinct fauna of Idaho and Oregon. — Professor E. D. Cope, referring to the remains of fishes from the middle valley of the Snake River in Idaho and eastern Oregon, stated that bones collected from sections now dry, but which had formerly been portions of lake-basins in the Oregon district, indicated a close relationship with the fishes now found in the remaining lakes and rivers. The number of species of fishes collected from the Idaho beds amounts to twenty-two. They are all distinct from those found in the Oregon basin, and cannot be identified with existing forms, although, with two exceptions, they belong to existing genera. Four of the families of fishes obtained from these beds are not now found west of the Rocky Mountains, except a single species of one of them (Percidae) in California. Of even greater interest was the fact that this fauna includes representatives of the Cobitidae, — a family of fishes entirely absent in the living fauna of North America. The presence of their remains in the Idaho beds indicates a probable former connection between North America and Asia. The names 'Idaho Lake' and 'Idaho deposits' were proposed for the lake and deposits now first described. The formation is distinct from any previously known, and is older than the Oregon lake-deposit. With the exception of fishes, the remains of but few vertebrates were found in the Idaho beds, although the Oregon deposits are full of the bones of mammals and birds. The means of indicating the exact geological position of these pliocene beds, as compared with those of Europe, was as yet wanting. — (*Acad. nat. sc. Philad.; meeting* June 19.) [66

Reptiles and batrachians.

Spermatozoon of newt. — Dowdeswell describes a very minute barb at the tip of the head of the spermatozoon of the newt: it measures 1.5 μ in breadth by 2 μ in length. He looked for it in other animals, but did not find it. — (*Quart. journ. micr. sc.*, 1883, 336.) C. S. M. [67

Nerves of the frog's palate. — Stirling and Macdonald describe fully the palatine nerves of the frog, their origin, and their general and minute distribution. There is a coarse plexus of medullated fibres and a finer plexus of naked fibres, which last innervate the blood-vessels and the glands, besides forming the ultimate ramifications of the nerves. In the course of the former plexus are scattered unipolar cells, each with a straight and a spiral fibre. There are, besides, many details given. This well illustrated and admirably written paper may be specially commended to histologists engaged in laboratory practice. — (*Journ. anat. physiol.*, xvii. 293.) C. S. M. [68

ANTHROPOLOGY.

Australian class systems. — In the Australian division of the tribe the communes are represented by two primary classes, each of which has a group of totem names, which are chiefly names of things animate or inanimate. The two primary intermarrying classes are over a large part of south-eastern Australia called Eaglehawk and Crow. Each group of totem names is a representation of its primary; and, as a general rule, any one of the group may marry with any other of the complementary group. If the primaries are A and B, and the groups, 1, 2, 3, etc., and i, ii, iii, etc., in certain localities, A 1 must marry B i only, and so on. The next change is the subdivision of A and B as in the Kamilaroi, thus: —

$$A\left\{\begin{matrix} a \\ \\ \alpha \end{matrix}\right\} 1,\ 2,\ 3,\ \text{etc.}$$

$$B\left\{\begin{matrix} b \\ \\ \beta \end{matrix}\right\} \text{i, ii, iii, etc.}$$

The effect of this is to remove the woman of the second generation from the possibility of marrying her father. Were this not so, the law 'A (male) marries B (female)' would permit A to take his daughter to wife, the simpler law forbidding the marriage of brothers and sisters only.

Under the form $a + \alpha = A$ and $b + \beta = B$, each half of an original class has marital rights over the women of one particular half of the other class, whose children do not take the class name of the mother, but of the sister class. For example: $\alpha + \beta = b$, who must marry a; and the children of the third generation, by mother right, will be again α and β. Mr. Howitt, who has worked out these systems with great patience, is of the opinion that this subdivision into classes was designed to render impossible those unions which were considered, and are now considered, as deep pollution. He has certainly given the most rational explanation of aversion to mothers-in-law. Under the old *régime* a daughter was of the clan of her mother, and B could marry any A. The law against looking at a mother-in-law, therefore, was to prevent the possibility of marrying her.

Mr. Howitt sums up his labors in the following conclusions: 1. The primary division prevented brother and sister marriage; 2. The secondary, intermarriage between parents and children; 3. The prohibition of intercourse between a woman and her son-in-law prevented connections not to be reached by class rules; 4. These changes were all reformatory in the community. — (*Journ. anthrop. inst.*, xii. 496.) J. W. P. [69

Region of man's evolution. — Mr. W. S. Duncan is the author of a paper upon the probable region of man's evolution, in which the following points are made. Man formed one of a set of families of man-like animals, somewhat similar to the present apes. Since only the lowest members of the Primates have been distributed to the eastern and the western continent, it is probable that the Primates originated within the arctic circle, while the higher groups sprang from the eastern continent: man, therefore, did not originate within the arctic circle, nor in the new world. The Cynopithecidae, since tertiary time, have been spread over nearly the entire eastern continent. The Semnopithecidae have been dispersed over central and western Europe to southern Europe and south-eastern Asia, as far south as Ethiopia. The anthropoid apes have been more circumscribed, but all the genera of living apes are derived from southern Europe and subtropical Asia. As apes existed in Europe and Asia before they reached the tropics, so we may infer that man existed in Europe and Africa before the low types, the Akkas and the Aetas, occupied tropical Asia and Malasia. The present habitat of the apes is not conducive to change: we must look to some region where apes were compelled to change their food and modes of locomotion. The stoppage of the southern migration by vast sheets of water shut up the apes in temperate regions. The crowding of other animals in the same locations sharpened the intelligence of the precursor of man. Here, then, Mr. Duncan supposes the great conflict and transition from man-like apes to ape-like men took place. — (*Journ. anthrop. inst.*, xii. 513-525.) J. W. P. [70

Tylor's lectures at Oxford. — The concluding portion of Dr. Tylor's lectures on anthropology, delivered in the Oxford museum in February (see i. **1055**), is devoted to the history of the growth of practical art. "In considering the claims of anthropology as a practical means of understanding ourselves, we have to form an opinion how the ideas and arts of any people are to be accounted for as developed from preceding stages. To work out the lines along which the process of organization has actually moved, is a task needing caution. A tribe may have some art which plainly shows progress from a ruder state of things: and yet it may be wrong to suppose this development to have taken place among themselves; it may be an item of higher culture, that they have learned from sight of a more advanced nation. It is essential, in studying even savage and barbaric culture, to allow for borrowing." Illustrations are given by Dr. Tylor of this borrowing, one of which is quite amusing. The later Danish travellers among the Eskimo enter very minutely into the description of the tools and dress of these people, before contact with Europeans, meaning the post-Columbian voyagers; but, unwittingly in many instances, they are describing fashions and forms borrowed from the Skraelling ancestors of these very writers a thousand years ago. Another very important point discussed in the lectures is the possibility of national degradation. Dr. Tylor was the first to discover, after the battle between the advocates of 'degradation' and those of evolution, that both were right, and that a proper view of human history must include both vicissitudes over and over again, and the commingling of both in every degree of complexity. Mr. Tylor gives a succinct account of the formation of the Pitt-Rivers collection, now housed at Oxford, and, in commenting upon the evolution of gesture-speech, pays this tribute to our country: "The labor and expense which anthropologists in the United States are now bestowing on the study of the indigenous tribes contrasts, I am sorry to say, with the indifference shown to such observations in Canada, where the habits of yet more interesting native tribes are allowed to die out without even a record." With very great shrewdness the speaker discussed the subject of magic and the benefit derived from even such useless search as that for the 'lost tribes of Israel.' — (*Nature*, May 17.) J. W. P. [71

The North-American Indiana and the horse. — Professor Hovelacque, in his recent work Les races humaines, gives as one of the important characterizations of the North-American Indians the statement that they do not breed horses, leaving it to be inferred from the context that they obtain their supply from wild herds. It may be remarked, that, however general the use of horses is at this time among the Indian tribes of the great plains, an ethnologic distinction based upon any treatment of that animal — a European importation and intrusion — is hardly legitimate. For centuries after the Columbian discovery but a small proportion of the tribes of North America ever saw a horse. The fact that the horse was not known to or used by them in their prehistoric condition constitutes an important element in establishing their position in the ethnic scale, their rise from savagery and barbarism having been retarded by that deprivation. Further, it must be suggested that there is little evidence, apart from the novels of Capt. Mayne Reid and similar authorities, of the existence in North America of herds of wild horses similar to those in South America, sufficiently large to supply the Plains tribes. There were, doubtless, some wild horses, the descendants of those imported by the Spaniards, in a condition to be captured by a past generation; but probably no living Indian has relied upon recruiting his stock from such herds, and his horses have been obtained by the civilized method of purchase or the more convenient process of stealing. The latter expedient has of late years been stopped by the powers of the United States authorities: so some of the tribes have learned to breed from their horses, though as yet the practice is limited by the same want of prudence as is shown in their neglect to provide food and shelter for their ponies. The whole connection of the tribes with the horse simply shows a course of education to a certain extent by a foreign civilization. The statement of M. Hovelacque is therefore as untrue in fact as it is unphilosophic as an ethnic characterization. — J. W. P. [72

EARLY INSTITUTIONS.

Land-holding in South Africa. — Sir H. Bartle Frere gives us an account of the systems of land-tenure among the aboriginal tribes of South Africa, — Bushmen, Hottentots, Kaffirs. Among the Kaffirs, if a man wishes to leave the paternal kraal, he seeks a tract of unoccupied land, and builds a kraal for himself. His wives proceed to cultivate as much land as they please, and the live-stock is turned out to pasture. The settlement descends from father to sons, unless, as often happens, this is prevented by the chief or an enemy. Titles rest simply on force. A man owns the land he occupies as long as he can hold it by his own might, or with the aid of the chief, or the tribe, if this is given. Authority of the chief or elders to resume or recognize possession has not been discovered by Sir Bartle Frere; but he says that it may, perhaps, be discovered by future investigators. — (*Journ. anthrop. inst.*, Feb.) D. W. R. [73

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Naval bureau of ordnance.

Experiments at Annapolis. — By direction of the Naval bureau of ordnance, experiments with the six-inch steel gun were resumed at the experimental battery recently, the chief object being to develop and encourage the home manufacture of steel projectiles. Steel projectiles manufactured by the Midvale steel company near Philadelphia, having different physical characteristics as to toughness, extensibility, etc., were fired at a target consisting of two mild steel five-inch plates strongly bolted together, and backed with twenty inches of live-oak. The first and the second shots broke up; the third pierced the plates, and was stopped by the backing; while the fourth perforated target and backing, and buried itself in a mound of earth beyond the target. This projectile had an initial velocity of 1,983 feet, and weighed 75 pounds. The charge of powder was 32 pounds, and the striking energy per inch of shot's circumference was 108 foot-tons. The results indicate that there will be no serious difficulty in procuring the proper material for armor-piercing shells in this country.

A somewhat remarkable result was obtained with a projectile weighing 52 pounds, and a charge of 33 pounds of powder. The muzzle velocity obtained was 2,323 feet per second, with a pressure of about 13 tons. The ratio of charge to projectile was adopted as being nearly that which will be used in the new ten-inch guns designed by Commodore Sicard. These guns will be manufactured at the Washington navy-yard, and are intended for the batteries of the four double-turreted monitors.

It does not necessarily follow that results equally favorable will be obtained with the ten-inch gun, since the masses of both charge and projectile will be greatly increased. The pressures will doubtless be higher; but these guns will be sufficiently strong to withstand a working pressure of more than 25 tons to the square inch. The indications, however, are, on the whole, extremely favorable to the success of the ten-inch gun.

This experiment is likewise interesting when compared with the record of a six-inch gun constructed by Sir William Armstrong, in which, with an 80-pound projectile and a charge of 55 pounds of powder, a muzzle velocity of 2,297 feet was reached with a pressure of 21 tons. In the latter case the ratio of charge to projectile is 11 : 16, whereas in the former case the ratio is 11 : 17½. It is to be regretted that the size of the chamber of this experimental gun does not permit the employment of a larger charge of powder.

Two six-inch guns, representing the types proposed for the broadside batteries of the new steel cruisers, are now in process of construction at the Washington navy-yard, and will be ready for testing in August. — J. M. B.

U. S. magnetic observatory at Los Angeles, Cal.[1]

Magnetic observations. — There is at present but one self-registering magnetic observatory within the limits of the United States. That observatory is located in Los Angeles, Cal.; and the object of the present article is to present a brief description of the observatory and its work, together with a short account of its origin.

Continuous series of magnetic observations, covering longer or shorter periods, have been made at several stations in North America; but, with two exceptions, they have all been made on the eastern side of the continent. We have a series of observations of five years (1840–45) at Girard college, Philadelphia, by A. D. Bache; six years' observations at Key West, Fla. (1860–66), by the U. S. coast-survey; and a long series, still continuing, at Toronto, Canada (1841–83). We have, further, a series of nearly five years of photographic records taken at Madison, Wis., by the U. S. coast and geodetic survey.

On the western coast the only continuous series of magnetic observations we have, were made by the Russian government at Sitka at the magnetic and meteorological observatory established in March, 1842, and maintained until the cession of Alaska to the United States in October, 1867; and the series of hourly observations at Point Barrow in 1852–54 by Capt. Maguire, R.N. Up to the present time, a great part of these observations have remained undigested and undiscussed.

It was therefore contemplated by the coast-survey, many years ago, to obtain a continuous series of magnetic records from some station on the western coast of the United States; and, with this end in view, an Adie magnetograph of the latest and most approved pattern was purchased in 1860. The outbreak of the war, however, prevented the carrying-out of this plan.

The instruments remained packed until 1878, when a favorable time seemed to have arrived to put it to use. Assistant C. A. Schott, aided by Mr. Suess, then set it up for trial in the basement of the coast-survey office in Washington. Some minor defects of construction were remedied, and the magnetograph set to work in January, 1879. It was kept going for about two weeks on trial, and found to perform satisfactorily. During this time, it was inspected by Superintendent Patterson, and its workings observed by various members of the survey. At the close of this trial it was packed up for shipment to some station in California.

It was found, however, that more money would be required to run the instrument than could be then set apart for this work, and it therefore remained in the coast-survey office.

In response to the invitation of the International polar conference, our government consented, in 1881,

[1] Communicated, with permission of the superintendent of the U. S. coast and geodetic survey, by Marcus Baker, acting assistant in charge of the observatory.

to the establishment of two observing stations in high northern latitudes. Observations, especially of meteorology and magnetism, were to be undertaken; and it was arranged to carry on these observations under the joint auspices of the signal-service and coast and geodetic survey. The executive management of these stations, the selection of observers, etc., were put under the direction of the chief signal-officer. The coast-survey co-operated by furnishing such magnetic instruments as were on hand, and by training, during the short time available for their work, the magnetic observers selected by the signal-office. It is to be regretted that there was not time enough to procure suitable differential instruments for the stations.

Two parties were despatched to the north, — one to Lady Franklin Bay, near the northern end of Greenland, under the charge of Lieut. A. W. Greely; and the other to Point Barrow, Alaska, under the direction of Lieut. P. H. Ray. Both these parties reached their destination in the fall of 1881.

It was the wish of the International polar conference that all the northern stations should be occupied three years; and a special effort was to be made to secure a complete and continuous record from August, 1882, to August, 1883. In the spring of 1882, additional observers were selected by the signal-office to replace any of the former ones that might have become disabled, or to act as auxiliaries, should such be needed. These magnetic observers, like their predecessors, received instruction at the coast-survey office prior to their departure for the north; and a set of differential magnetic instruments, hastily constructed, was sent to Point Barrow.

The spring of 1882 seemed, therefore, a peculiarly favorable time to put the Adie magnetograph to work, and to secure at one and the same time the long-desired series of magnetic observations from the western coast, and a series which would also be available for comparison with those observations made at the International polar conference stations. It was therefore mutually agreed by the signal and coast survey offices to establish a magnetic station at the joint expense of the two offices. In the case of the northern stations, the management was intrusted to the signal-office. The expense of the Lady Franklin Bay station was specifically provided for by act of Congress. The expense of the Point Barrow station was to be borne by the signal-service and coast and geodetic survey jointly. In the new station to be established in California, and which was to be devoted to observations of magnetism only, the management was left entirely to the coast-survey.

At first San Diego was suggested as the site of the new station, it being the place on the western coast of the United States farthest from the northern stations. A somewhat better location, nearly as far south, was, however, finally selected in Los Angeles, Cal.

Plans for a building were prepared in Washington, and forwarded to Assistant J. S. Lawson of the coast and geodetic survey, who proceeded to Los Angeles, and superintended the selection of a site, and erection of a building, in June and July, 1882.

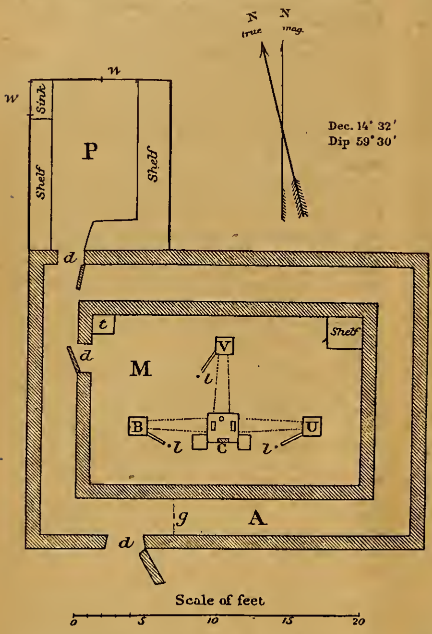
In July, 1882, the instruments, were shipped to Los Angeles, Cal., in the care of Mr. Werner Suess, a skilful mechanician in the coast-survey, and who had attended to the mounting of the instrument in 1878, and to its packing up after the test trial was complete.

At the same time, the writer was assigned to the charge of the observatory, with instructions to mount and adjust the instrument, determine its constants, and proceed to bring out a continuous record of the changes in the elements of the earth's magnetism. Leaving Washington July 26, he arrived in Los Angeles Aug. 7, 1882, where he found Mr. Suess in waiting, and the observatory complete.

After arranging preliminaries, the work of mounting and adjusting the instrument was begun, and pushed forward as rapidly as possible. Observations for the determination of the constants and scale values were made; the compensation of the vertical-force magnet for temperature was made; temperature coefficients were determined; and finally, on Sept. 28, every thing was in readiness, and the first sensitive paper was put upon the cylinders, and the first record made. The first few days were in the nature of a trial. A slight re-adjustment was made on Oct. 13, after which every thing worked satisfactorily. On Oct. 31 the horizontal and vertical force constants were redetermined; and since that date the instrument has continued to work almost perfectly, and to make a complete and continuous record of the changes of all the magnetic elements.

The observatory is situated in latitude 34° 03′ N., longitude 118° 15′ W. from Greenwich, and 317 feet above the level of the sea. It is on a rather steep hillside sloping to the south-west in the grounds of the Branch normal school in the city of Los Angeles, exactly one mile, in a direct line, from the centre of the plaza, or park, in the centre of the old town, or about a mile from the central business part of the town. Street-cars run within two squares of the observatory. It is on adobe soil underlaid by clay, and in the midst of an orange plantation formerly known as Belle Vue Terrace.

The observatory is built of redwood fastened with copper nails, is double walled, with an air-space 2.5 feet between the walls; which walls are fourteen inches thick, and filled with adobe soil. It is twenty-eight feet long by twenty-one feet wide, and painted white. The entrance to the observatory is on the south side. On the north side is the photographic or dark room, P, where the various photographic processes are carried on. This room is twelve feet long by ten feet wide. The accompanying plan will show the arrangement of rooms and instruments. The three magnets are placed, the unifilar or declinometer, U, to the east, the bifilar or horizontal-force magnetometer, B, to the west, and the vertical-force magnetometer, V, to the north, of the central driving-clock, C. A picture of the instrument, showing it as a whole, and also showing details, may be found in Gordon's Electricity and magnetism. For illumination, student-lamps burning kerosene-oil are used, and yield satisfactory results. The record is made on paper sensitized by the bromo-iodide process. The paper is sensitized at the observatory. Each trace contains two days' record; and the record is absolutely complete and continuous, except the time lost in changing papers to begin a new record, and in 'moving spots,' or shifting the luminous dots to get the second day's record on the same sheet. The time required for the first operation is from seven to eight minutes; for the second, from two to three minutes. Thus only about ten minutes are lost in two days, or an average of five minutes per day, —



a quantity too small to be of any importance on any occasion thus far observed.

One minute of time on the traces is represented by $\frac{1}{100}$ of an inch approximately, and a movement through one minute of arc by the unifilar magnet is represented on the trace by $\frac{3}{100}$ of an inch. A motion of the bifilar magnet of one scale division, represented on the trace by 0.027 inch, corresponds to a change of horizontal force of about its $\frac{1}{9000}$ part. The traces can readily be read off within half a scale division, or changes of force of its $\frac{1}{18000}$ part are recorded. This adjustment has not proved too sensitive, as the luminous dot has never left the recording cylinder, except once for a short time during the great magnetic storm of November, 1882.

Visitors are admitted to the observatory, and the traces generally show their presence by a break in the curve.

The instrument records, as is well known, changes of declination, changes of horizontal force, and changes of vertical force. Each of these changes is recorded on a separate sheet, or trace as it is called; and thus, on an average, forty-five traces are produced each month. These traces are six inches by sixteen inches and a half, and are made on plain photographic paper prepared for use at the observatory.

This preparation consists of two processes, salting and silvering. The salting process, as it is called, consists in soaking the paper from ten to fifteen minutes in a bath of iodide and bromide of potassium, with a little tincture of iodine added, after which the paper is hung up to dry. This process is carried on in the daylight.

The silvering or sensitizing process is carried on in a room as dark as can well be made, and then lighted up dimly with a red lantern. Some difficulty has been found in keeping the room dark enough, and on some occasions the silvering has been done at night.

For silvering, four wooden trays are placed in a row: the first containing a bath of nitrate of silver, acetic acid, and water; the second, distilled water; the third, a weak solution of chloride of ammonium; and the fourth, distilled water. A sheet of salted paper is then floated on tray no. 1, special care and some skill being required to prevent (*a*) any of the solution from getting on the *back* of the sheet, and (*b*) any air-bubbles from clinging to the front side of the sheet. The first defect produces stains, and the second, spots. In about nine minutes the paper is transferred to tray no. 2, being floated on as in the case of no. 1, and a new sheet is floated on tray no. 1. In about nine minutes more, the sheets are moved forward, as before; the paper in no. 2 is floated on no. 3; that in no. 1 is transferred, as before, to no. 2, and a new sheet floated on no. 1. This continues till tray 4 is reached; after which the sensitizing is complete, and the paper is then hung up to dry in the dark. Special care is necessary in hanging up the wet paper to avoid stains from the fingers, from the line, or from the pin which holds the paper on the line.

After drying thoroughly, the papers are taken down, packed in a large envelope, and kept in a dark drawer to be used as needed. From this envelope the sheets are transferred to the three recording cylinders prepared to carry them. They remain two days upon the cylinders, and thus receive two days' record. At quarter-past nine A.M. of each alternate day the papers are changed.

Over the central driving-clock is hung a heavy orange-flannel curtain. To change papers, the attendant, with the envelope of sensitive paper, goes behind this flannel curtain, through which sufficient light from the three lamps comes to enable the change to be made without further artificial light. The orange flannel serves to satisfactorily exclude actinic light.

The traces, removed from the cylinders, are then carried in a large envelope to the dark room, and there developed, the developer used being pyrogallic acid. The best developments are those which take place rather quickly, in about ten to fifteen minutes. When the development is slower, the traces are usually found inferior. After the development is complete, the traces are fixed in hyposulphite of soda cleansed in a saturated solution of alum, washed for about two hours in running water, and then hung up to dry. After drying, the date is stamped upon them. The exact instant of beginning and ending of each line on the trace, together with the corresponding scale value, is written on. Time observations, with sextant and artificial horizon, are taken from time to time, usually monthly, to regulate the standard chronometer.

After the traces have been thus completed, they are practically paper negatives, from which any number of copies may be made photographically. Two sets are made by the well-known blue-print process. The traces require no special treatment, such as oiling, waxing, etc., for the successful application of this process.

For tabulating from the traces, it is found most convenient to use a ruler subdivided into hourly divisions for the time scale, and a triangular piece of card-board upon the edge of which is ruled the scale corresponding to the trace to be read. The unifilar and bifilar traces have all been read, tabulated, and the means calculated. The vertical-force traces have not yet been read.

There is also in the magnet-room of the observatory a thermograph, which records the temperature every half-hour. From the records produced by it, the time of maximum temperature in the observatory is found to be about five P.M., and the time of minimum temperature, about half-past eight A.M. At these hours the thermometers under the bell glasses and near the magnets are read; and from these readings it appears that the magnets are subjected to an average daily range of temperature of about 1¾° C.

On the 14th, 15th, and 16th of each month, observations are made to determine the absolute declination, dip, and intensity. These observations are made in the usual manner of taking such observations by field parties in the coast and geodetic survey. Monthly reports and returns of results are made to the superintendent of the survey.

The declinations and dips have all been computed, but the intensities only approximately as yet. The following table contains the declinations and dips resulting from the monthly absolute determinations. Each declination is the mean derived from the elongation on three successive days, and each dip is the mean of six sets with two needles on the same three days.

U. S. magnetic observatory at Los Angeles, lat. 34°03′, long. 118°15′ W. G.

	Declination.	Dip.
1882, Sept. 14, 15, 16	14°35.5′ E.	59°30.1′
Oct. 14, 15, 16	33.7	30.2
Nov. 14, 15, 16	34 6	29.7
Dec. 14, 15, 16	32.7	31.6
1883, Jan. 14, 15, 16	35.1	30.8
Feb. 14, 15, 16	31.5	28.4
March 14, 15, 16	32.4	31.7
April 14, 15, 16	32.1	29.2
May 14, 15, 16	32 5	29.7

The horizontal intensity is approximately 5.97 in British units = 0.275 dyne.

U. S. magnetic observatory,
Los Angeles, Cal., June 1, 1883.

NOTES AND NEWS.

Professor Huxley has been elected president of the Royal society of London, in the place of Mr. Spottiswood.

— The recently issued report of the signal-office for 1881 contains a record of primary and secondary observing stations, established in that year in Alaska, with summaries of observations at some Alaskan stations in preceding years. There is also some account of the fitting-out of the Greely expedition to Lady Franklin Bay and that to Point Barrow. But the most important article for arctic students is the report of Prof. E. W. Nelson on the meteorology of St. Michaels, Norton Sound, where, as is well known, he had been stationed for four years; his leisure being employed in pursuing investigations into the natural history and ethnology of the region with the greatest energy, devotion, and success. The article itself being a summary and an abstract, with somewhat wider limits in regard to the treatment of auroras and the so-called 'polar band' formation of clouds, it will not be attempted to condense it here, but merely to call attention to some of its leading features. According to observations by Danenhower, the position (hitherto somewhat uncertain) of St. Michaels is latitude 63° 28¼′, and longitude 162° 04¾′ west. The mean annual temperature for the period is 25°.5 F. The highest observed temperature was 75°, and the lowest, — 55°. A curious fact was noted with great regularity. In early winter darkness comes on between three and four P.M., and the temperature falls until about six P.M., when a *rise* follows of two or three hours' duration, and sometimes five or six degrees in extent, followed by the usual steady nocturnal fall. It does not result from changes in the wind, but may be due to greater radiation immediately after sunset from the land, resulting in local atmospheric movements, causing warmer air from the adjacent sea to flow in the vicinity of the station.

Alongshore, winds N., N.E., S., S.E., S.W., are most prevalent. Winds off the sea, N.W. and W., are the least frequent, not exceeding together over ten per cent of the whole. Topographical bias is, however, distinctly evident, as at most stations in Alaska.

The measured precipitation averaged twelve inches and a quarter, to which Mr. Nelson estimates a correction of one-half more must be added for unmeasurable drizzle and blown snow. The record and discussion of the aurora is a valuable contribution to the subject, and cannot be summarized. Thunderstorms are almost unknown. Lightning was observed but twice, and no thunder was heard during the whole period. It is referred to as reported common on the upper Yukon in summer; but in 1865–68, by the explorers of the Telegraph expedition on the upper part of the river, thunder and lightning were not observed on a single occasion. There are but two seasons at St. Michaels, — winter (October–May) and summer (the remaining five months). The sea is open until about Oct. 15; and the ice disappears in the spring, usually in early June. The tides are small, but over the shallow sea adjacent the rise in level due to gales is often sufficient to submerge the marshy shores for miles inland. Gardening is not a success, except for turnips, radishes, and lettuce. The earliest birds, chiefly geese, begin to arrive in April; and the migration continues to June, the main body of birds arriving between May 15 and 25. Most of the birds leave for the south in August, and the first sharp frost of September sends away the laggards.

— On the 1st of January, 1883, there were in existence 79 societies of geography, distributed all over the world, with about 38,000 members.

— The American society of mechanical engineers met at Cleveland, O., June 14, President E. D. Leavitt, jun., of Cambridge, Mass., in the chair. Eighty members were present, and fifty-four were elected, raising the total membership to four hundred and sixteen. The papers were generally short, plain, and practical. Mr. J. K. Holloway described a steam starting gear for throwing marine engines 'off the centre.' It consists of a steam-cylinder and a friction-wheel on the main shaft, which can be actuated by the auxiliary steam-cylinder. The device works either way, and may be applied repeatedly if necessary. Mr. Charles N. Comly detailed his experience with lubricating materials, resulting in the substitution of grease for oil. Other members had found grease the cheaper lubricant, but had observed that it had a much higher coefficient of friction than oil. Mr. J. E. Sweet described a new method of casting iron pipe having flanges, making chilled flange-faces and cored bolt-holes. Other papers remain to be reported. During the session, it was announced that an honorary degree had been conferred on President Leavitt by the Stevens institute of technology.

— W. H. Edwards announces that he will not, at present, complete the Synopsis of species commenced in the tenth part of his Butterflies of North America, but substitute for it a mere list of species, which will be issued with the next (concluding) part of the second series.

RECENT BOOKS AND PAMPHLETS.

Annuaire de l'électricité pour 1883. (1re année), par A. Révérend. Paris, *Gauthier-Villars*, 1883. 216 p., illustr. 8°.

Blanchet. Notice sur la naturalisation à Bayonne d'une nouvelle plante exotique. Dax, *impr. Justère*, 1883. 15 p. 8°.

Delfau. De la maladie de la vigne causée par le phylloxéra et de son traitement efficace, facile et économique. Perpignan, *impr. de l'Indépendent*, 1883. 34 p. 8°.

English, T. Alfred, Haussen, C. Julius, and Sturgeon, J. Report on a scheme for supplying compressed air motive-power in the town of Birmingham; with tables and formulae for calculating the useful effect obtained from compressed air, and examples and diagrams showing the application thereof; with confirmatory report by Prof. H. Robinson. New York, *Spon*, 1883. 60 p., illustr. 4°.

Farmer, E. J. The resources of the Rocky Mountains; being a brief description of the mineral, grazing, agricultural, and timber resources of Colorado, Utah, Arizona, etc. Cleveland, 1883. illustr. 8°.

Forbes, P. R. Sciences and spiritualism. Paris, *impr. Schlaeber*, 1883. 16 p. 8°.

Forestier, C. Parallèle entre l'instruction des sourds-muets par le langage des signes et leur enseignement par l'articulation artificielle, suivi de quelques observations sur la méthode du célèbre Périère et sur les résolutions qu'a votées contre l'enseignement par le langage des signes le congrès international tenu à Milan du 6 au 12 septembre 1880 pour l'amélioration du sort des sourds-muets. Lyon, *impr. Pitrat*, 1883. 8+90 p. 8°.

Frankland, P. F. Agricultural chemical analysis. Founded upon 'Leitfaden für die agriculturchemiker,' von Dr. F. Krocker. London, *Macmillan*, 1883. 320 p. 8°.

Guenot, C. Les chinois et les indous. Limoges, *Barbou*, 1883. Bibliothèque morale. 87 p. 12°.

India-rubber and gutta-percha and their cultivation. London, *Haddon*, 1883. 8°

Jaffré, P. Théorie complète élémentaire des occultations. Saint Nazaire, *impr. Fronteau*, 1883. 24 p., pl. 4°.

Keeping, W. The fossils and paleontological affinities of the neocomian deposits of Upware and Brickhill; with plates: being the Sedgwick prize essay for 1879. London, *Cambridge warehouse*, 1883. 8°.

Knight, D. Morphology of the vertebrata. With plates. London, *Dryden*, 1883. 8°.

Kuropatkin. Kashgaria (Eastern or Chinese Turkestan): Historical, geographical, military, and industrial. Translated by Major Gowan. London, *Thacker*, 1883. 8°.

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SCIENCE.

FRIDAY, JULY 20, 1883.

THE U. S. NATIONAL MUSEUM.

I.

The brief pamphlet recently issued by the assistant director of the museum as his special report for 1881 is, perhaps, one of the most important documents which has yet appeared in the history of science in this country. It represents the institution which in the natural course of events should become the leading organization of its kind on this continent, and also furnish the motive and the pattern for the many similar copies which will naturally follow its example in other parts of our extensive possessions. It also presents to foreign nations the ideals, which, they will naturally suppose, represent our existing scientific culture and the tendencies of science in this country. They will hardly imagine that it has not been debated at all by scientific men at large, that it is the work of no representative commission, and that it cannot in any sense be considered as the deliberate result of consultation with the leading men of the United States in all departments.

In this respect, we think that the action of the government — if the plan is, as we understand, already adopted in the museum — is open to the severest criticism, and that it shows a curious want of prudence to definitely settle the future of an institution in which the whole country is more deeply interested than any other of its kind, without allowing the voice and criticisms of scientific men to be heard. It is certainly a wide departure from the wise example of the Smithsonian, and shows, that, at Washington, success has already begun to dull the edge of the wise forethought which led to such successful results in the planning of that institution.

That the museum must be a loser in influence by such a proceeding lies in the nature of things. The science of this country is certainly not responsible for the plan, and, however good it may prove to be, has had no proper opportunities for expressing its opinion about a matter in which its deepest interests are concerned.

In his opening considerations, Mr. Goode divides museums into three classes, — those for record, those for research, and those for education. He considers that all three of these objects are essential to the development of any comprehensive and philosophically organized museum. By record, the author means the preservation of collections which have served as the instruments of past research; and by research, the accumulation of materials of all kinds to provide for new investigations. The author here assumes an historical standard, and thinks that the objects of museum administration determine their classification; whereas, in our opinion, practical considerations really settle the class to which a given museum should be referred. There is, as the author remarks, no separation of the two purposes of record and research; and it would perhaps have been clearer to the inexperienced in this branch of technology if the preservation of records, and accumulation of materials for research, together with adequate provision for the publication of original results, which is not mentioned by him, had been defined as the inseparable trinity of a museum of the first class. Mr. Goode's opinion, that such museums should have exhibition-rooms, and display both their records and the results of research, indicates a broad and well-balanced judgment of the aims of museum administration. The prevalent opinion among young investigators, that no public display of records should be made, arises from obstacles which the expenses of exhibition have heretofore presented to the successful performance of the proper functions of this class of museums in the encouragement of research, and also to their frequent failures as instruments for the education of the public.

Two functions, that of museums of research and that of museums of education, have been confused in their display of specimens; but, while this shows the necessity of a separation and a change of policy in their choice of collections for exhibition, it does not justify the withdrawal of valuable and useful records from public view. Leave to consult original specimens cannot be lightly granted, and the idiosyncrasies of their guardians is a large element of uncertainty in the way of those desiring to see such treasures. There are also classes of persons daily on the increase who should, at any rate, have the privilege of seeing them, though not fit to be trusted with their direct handling; and the wants of this class cannot be justly disregarded. We are therefore most heartily in sympathy with Mr. Goode in his opinion, that the highest value of original records is given to them when they are placed on exhibition; but we probably differ in thinking that this should be done in museums or collections exclusively devoted to research, and meant for the use of the special student rather than the general public.

Mr. Goode's third class of museums, the educational, we should designate as the second class; since these are often separated from the former, and ought always to be conducted with distinct purposes, and governed by a class of men who are familiar with the educational wants of the public, i.e., all those classes of persons who must get their information through the glass, and are not permitted to handle specimens. The needs of this class are but imperfectly understood by the investigator, or, if understood, very apt to be considered by him as of slight importance. It is certainly not his essential function to satisfy these demands, as in the case of the true educator, and as should be the case with the curator of an educational collection.

Mr. Goode's ideal of a great educational museum is accomplished by the union of the natural history and industrial museums; and this has evidently arisen from his experience and study of similar unions occurring more or less accidentally in the different great exhibitions held in civilized countries of late years. He points out, that, while these great industrial exhibitions have shown a tendency to become purely commercial, they have served, wherever they have been held, as the starting-points, in time and materials, of permanent industrial museums. The effect of the world's fair in Philadelphia in 1876, in accordance with this law, demonstrated the educational value of a more permanent industrial museum, and suggested that an immense field of usefulness would be open to an institution which should be based upon similar grounds, but which would endeavor, by a more efficient and scientific arrangement of its specimens, to impart "a consistent and systematic idea of the resources of the world and of human achievement."

This novel and somewhat startling aim is announced as the future guiding-star of the National museum, which is declared to be in the best possible trim for the accomplishment of such a purpose, since it is now starting anew, and is not encumbered by the immense masses of duplicates which have become the most serious obstacles in the path of the older museums. It is, in other words, free to choose the path of its future work; and while this seems to be true, and the author must be acknowledged the best judge of the fact, we do not find any allusion to the accumulations formerly stored in the Smithsonian, nor as to how these and other collections, made upon the old basis for purely scientific research, are to be brought into harmony with the new ideal.[1] It is much to be regretted, that, in this preliminary announcement of so important a national enterprise, the author had not taken more space for such interesting explanations, and also for the fuller consideration of the arrangement of topics according to their relative importance.

This treatise shows, nevertheless, in all its

[1] Though we do find (as quoted in italics immediately below) that these collections, and we presume those which will be continually flowing in from the Geological survey, the Fish-commission, and other sources, are to be arranged on a different plan from all the other collections. It would have greatly enlightened us if we could have known what this plan was, but nothing further is said of it.

parts, that the practical aspects and difficulties of the question have been studied with great thoroughness and ability, and have naturally absorbed the time and thoughts of the author, and taken, therefore, the most prominent place.

What seem to us the most valuable and fundamental of all the considerations are brought in as secondary. Thus we find an intimation only that the museum "attempts to show the evolution of civilization;" we cannot be wrong, it appears to us, in imagining that this is to be the great aim of the National museum; and again, "the collections should form a museum of anthropology, the word 'anthropology' being applied in its most comprehensive sense. It should exhibit the physical characteristics, the history, the manners (past and present) of all peoples (civilized and savage), and should illustrate human culture and industry in all its phases. The earth, its physical structure and its products, is to be exhibited with special reference to its adaptation for use by man and its resources for his future needs. *The so-called natural history collections — that is to say, the collections in pure zoölogy, geology, and botany — should be grouped in separate series, which, though arranged on another plan*, shall illustrate and supplement the collections in industrial and economic natural history." We felt immediately the deepest interest in knowing how so large a part of the National museum could be arranged on another plan without confusing the effect of the whole, but looked for explanations in vain.

The idea of making the National museum a museum of anthropology must, we think, command unqualified respect; and it seems to us to contain so much of future promise, that we feel all the more regret that the details of the scheme had not received the healthy purgation of general and expert criticism. The classification is also highly original, and shows the result of extensive study, and practical knowledge of ways and methods.

The general outlines of the scheme of classification, which is announced as provisional and open to necessary] modification, are as follows: the exhibition of articles is to be divided into eight large divisions, or 'sections,' including sixty-four smaller divisions; which last we shall, for convenience, designate under the name of 'topics,' to distinguish them from the sections into which they are grouped by Mr. Goode. — "Section I., Mankind; II., The earth as man's abode; III., Natural resources; IV., The exploitative industries; V., The elaborative industries; VI., Ultimate products and their utilization; VII., Social relations of mankind; VIII., Intellectual occupations of mankind."

We recognize the enormous difficulties in the way of the author of this scheme; and, while we congratulate him upon the successful handling of the details, — which we have not the space to quote in full, and therefore cannot do him personally full justice, — we must dissent strongly from the main ideas, which, we think, show the want of a broad and masterly comprehension of the philosophical ideas which should govern the classification and purposes of our National museum. The scheme itself, in this respect, is a curious mixture of the old notion, that, in order to understand man, we must necessarily start with the study of mankind, and of the modern idea of evolution. The legitimate process of instruction from this stand-point begins with the simplest forms of life, and follows up their developmental and evolutionary history in organization and in time, until we arrive at the most highly specialized forms. Man is the most highly specialized of all animals, physically and psychologically, and therefore, it is claimed, needs to be viewed in the light of all knowledge, unobscured by the prejudices and misconceptions which are liable to arise from the adoption of the opposite modes of study.

Certainly the former mode is incompatible with the thorough and direct method of studying the principles of evolution, whether these relate to one set of objects or another, and is not accordant with the idea of the 'evolution of civilization' and the evident necessity of expressing, in all the minor industrial collections, "the steps by which man has arrived at the present condition in every direction in which human industry has been exerted, — a graphic history of the development of the human culture and civilization."

These are Mr. Goode's own declarations of what seem to be the vital intentions of his scheme; and it is therefore a serious error, both practically and theoretically, when he places the natural history of man, including his psychology and individual manifestations, at the head of his scheme, in place of making this department the terminal one, to be viewed by visitors only after they had gone through with all the other departments.

The author has arranged the sections and sixty-four topics according to a system which is artificial, and irreconcilable with his intentions and his general objects, and shows this in the place assigned to mankind. Man is essentially the product of the forces which have acted upon this earth. Without going into the question of whether these forces were divine or material, which is of no value in such a technical discussion, it is certainly very illogical to place the conclusion before the beginning, the consequent before the antecedent, man before the earth. This may be very satisfactory to those who need, or think they need, to perpetually swing the censer before the old idol of man's supremacy in the universe; but it is none the less unnatural and illogical to have one mode of arrangement for the parts of a great collection, and another for the whole.

In a future number we shall consider some of the minor features of this elaborate scheme.

LIST OF TWENTY-THREE NEW DOUBLE STARS, DISCOVERED AT CAROLINE ISLAND, SOUTH PACIFIC OCEAN, BETWEEN APRIL 27 AND MAY 7, 1883, BY E. S. HOLDEN AND C. S. HASTINGS.

Star.	α, 1880.0.	δ, 1880.0.	p.	s.	Mags.	Observer.	Date.
	h. m. s.						
Stone, 6791	10 28 35	—54° 46′	250°	2″	8.5 – 9	Holden	May 1.
Anon.	11 31 28	—60 14	350	$1\frac{1}{2}$	8.5 – 9.5	Holden	April 28.
Lac., 4936	11 48 58	—55 25	230	2	7.5 – 8	Holden	May 1.
Anon.	11 57 40	—57 5	240	$1\frac{1}{2}$	8.5 – 9.5	Holden	May 4.
Lac., 5223	12 31 24	—55 16	205	$1\frac{1}{2}$	7.3 – 9.3	Holden	May 1.
Anon.	13 1 16	—52 5	200	$1\frac{1}{4}$	9.5 – 9.5	Holden	May 4.
Lac., 5434	13 6 59	—62 57	40	$1\frac{1}{2}$	7.5 –10	Holden	May 6.
Lac., 5738	13 48 28	—53 33	330	2	6.5 – 8.5	Russell	A. B.
			290	25	6.5 –13	Holden	May 2, A. C.
Lac., 5817	13 59 56	—49 18	30	$\frac{3}{4}$	7.5 – 7.5	Hastings	May 1.
Lac., 5844	14 6 14	—61 9	180	$3\frac{1}{2}$	7 – 9	Hastings	May 2.
Lac., 6066	14 41 16	—72 42	90	$1\frac{1}{2}$	6 – 8	Hastings	May 2.
Lac., 6136	14 50 35	—67 30	0	5	7 –10	Hastings	April 27.
Anon.	15 2 18	—40 31	70	4	7 – 8	Hastings	May 4.
Stone, 8250	15 3 33	—51 38	220	8	7.5 – 9	Holden	May 2.
Lac., 6259	15 6 36	—60 27	300	12	6.5 –13	Hastings	April 27.
Anon.	15 7 20	—68 8	0	$1\frac{1}{4}$	7.5 – 9	Hastings	May 2.
Anon.	15 8 40	—53 50	170	3	8 –10	Hastings	May 1.
Stone, 8348	15 14 18	—47 29	225	$1\frac{1}{2}$	8.0 – 8.5	Hastings	May 1.
ε Lupi	15 14 32	—44 15	175	$\frac{3}{4}$	3 – 6	Hastings	April 27.
Lac., 6488	15 36 11	—50 24	210	2	7 – 9	Holden	May 4.
Lac., 6540	15 44 44	—60 23	85	1	6.5 – 9	Hastings	May 2.
Stone, 9221	16 50 15	—56 25	125	2	7.5 –10	Holden	May 7.
Lac., 7315	17 23 16	—40 57	95	1	8.0 – 8.5	Holden	May 7.

THE UNITED STATES FISH-COMMISSION STEAMER ALBATROSS.[1] — II.

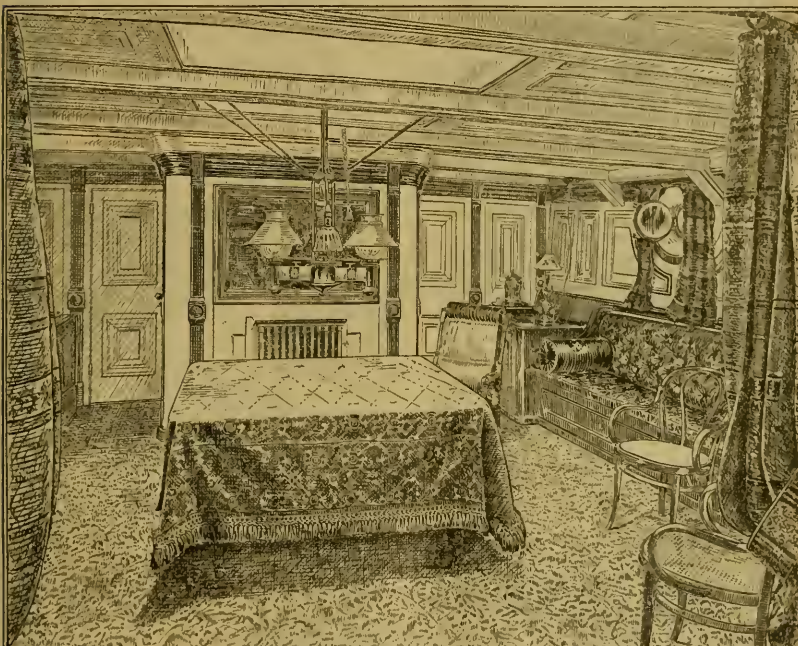
THE fitting-up of a small floating scientific laboratory, which might remain at sea for a month or more at a time, and yet include every necessary convenience, was a somewhat novel problem, and required a considerable amount of planning, based mainly upon past experiences of the fish-commission. The general arrangements are now, for the most part, complete, but they are subject to alteration and improvement.

The main laboratory (see figures, pp. 68, 69) is twenty feet long, twenty-six feet wide, and nearly eight feet high. The forward-end of the room is devoted to storage, and the sides and

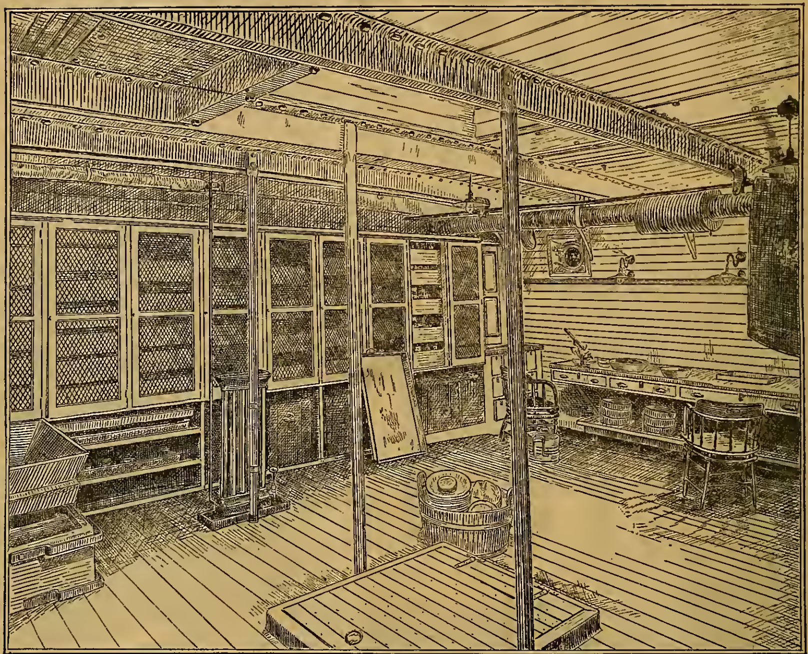
[1] Concluded from No. 22.

after-end to work-tables. The storage-case consists of a series of six double racks, with wire doors in front for holding the trays of bottles and jars, the trays being all of the same size, so as to fit any part of the case. Under the racks are six large bins for the tanks of alcohol in use, the large fish-pans, dishes, and other heavy laboratory utensils, and at either side is a small case for chemicals and preservatives. In one of the after-corners is a photographic dark room, and opposite to it the sink and water-supply. The remainder of the space on each side is occupied by a sorting-table, one being at the proper height to work while standing, the other while sitting. The after-bulkhead contains the arrangements for chemical and physical investigations, consisting of a broad table, with drawers and cupboards underneath, and racks above.

The storeroom is of about the same size as the general laboratory, though of less height, and is entirely fitted up for the storage of jars, bottles, tanks, alcohol, zoölogical specimens, and the lighter kinds of collecting apparatus. A single series of bins on a level with the floor extends around the entire room, excepting in front of the stairway, and serves as compartments for the copper tanks of alcohol, which are contained in uniform-sized boxes. In these bins there is room for fifty tank-boxes, each with a capacity of sixteen gallons, making a total of eight hundred gallons of alcohol which it is possible to carry in this way. Against the fore and after bulkheads, above the bins, are two sets of racks for bottle-trays, similar to those in the general laboratory. They are intended for the storage of the main supply of bottles and jars; and, as rapidly as those in the laboratory become filled with specimens, they are carried below, and their places supplied



CAPTAIN'S CABIN.



MAIN LABORATORY, FORWARD-END.

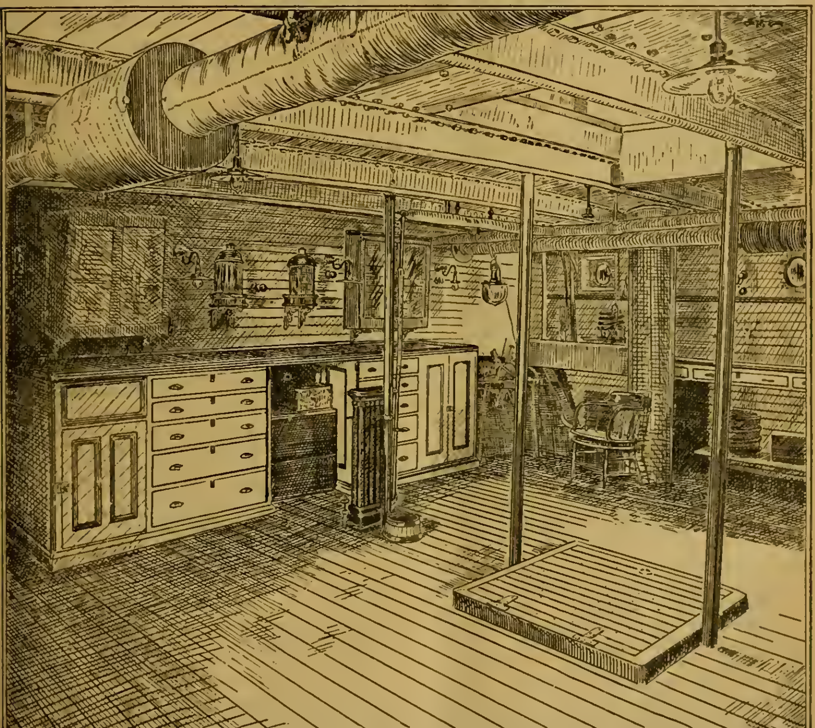
with empty ones, without the necessity of removing any from the trays. On the two sides of the storeroom are large, deep bins for nets and other light appliances, the dredges and trawls being stored elsewhere.

The deck-laboratory, which receives the greatest amount of light, is more especially arranged for study. The after-end is occupied by a bookcase, with a cupboard for the physical apparatus on one side; and the forward-end, by the medical case, and stairway to the lower laboratory. A large square table, with accommodations for four persons, stands in the centre of the room, under the skylight. Under one window is the sink, and beside it two upright cylindrical tanks for sea-water and alcohol, which empty by means of faucets. The other window-spaces are supplied with folding tables, which, when not in use, can be shut down against the wall. Arrangements are yet to be made in this room for small working-aquaria, where the living forms and colors of delicate marine animals can be studied and pictured. They will probably be modelled after the new style of hatching-jars, recently introduced at Washington, for the propagation of shad and salmon.

The Albatross is furnished with two propeller-screws instead of the usual number, one, to enable her to execute more readily the various manoeuvres demanded by the peculiar character of her work. They are right and left handed, — one being placed under each counter, — and measure nine feet in diameter. By their means the steamer can be turned completely around almost within her own length, and placed in position for dredging and sounding without the delays incidental to most exploring steamers. The motive power is furnished by two compound engines, with two cylinders each, — one of high, the other of low pressure, — the stroke of piston being thirty inches. The engines are slightly inclined, the upper ends of the cylinders being drawn inboard over the condenser, which is common to both engines, and forms their framing. The boilers are two in number, of the overhead return-flue pattern, and measure twenty-one feet and a half in length by eight feet and a half in diameter.

The proper ventilation of all parts of the ship was carefully considered during her construction, and the plan adopted has given the greatest satisfaction. It consists simply in withdrawing the foul air from the lower parts of each room through small ventilators, by means of a Sturtevant exhaust-fan with Wise's steam-motor attachment. The influx of air is from above, through open doors or ports; and a constant circulation is maintained, even in the lowest inhabited portions of the ship.

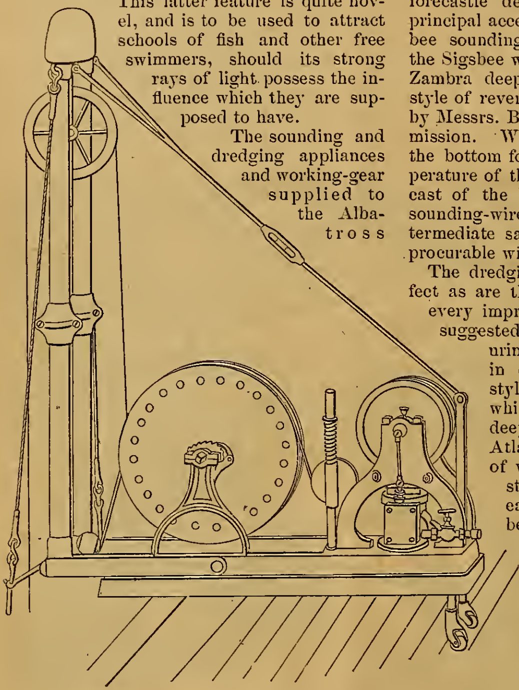
One of the most interesting features of the Albatross is the system of electric lighting, which has already been referred to. Some such method of replacing the dingy lamps common to most ocean vessels was rendered imperative from the fact that this steamer is supposed to continue her observations as regularly through the night as through the day, and the surrounding surface of the sea must also be lighted. To accomplish this, a hundred and twenty eight-candle B lamps of the Edison incandescent system are distributed through the ship; every portion, including the



MAIN LABORATORY, AFTER END.

holds, storerooms, and open decks, having its share. They are controlled by a Z dynamo, driven by an Armington and Sim's high-speed engine. An arc-lamp of great power, designed by Dr. O. A. Moses, and intended for illuminating the surface of the water, works in circuit with the same system; and there is also a powerful submarine lamp which can be lowered to any depth not exceeding a thousand feet. This latter feature is quite novel, and is to be used to attract schools of fish and other free swimmers, should its strong rays of light possess the influence which they are supposed to have.

The sounding and dredging appliances and working-gear supplied to the Albatross are mainly patterned after those which have been successfully introduced by the U. S. coast-survey and fish-commission in recent years. All sounding operations are to be conducted with steel piano-wire of No. 21 American gauge, on the system of Sir William Thomson, for which purpose two styles of sounding-machines are furnished. One of these is the invention of Commander Sigsbee, U.S.N., and the other of Lieut.-Commander Tanner, U.S.N. The Tanner machine, in which the reeling-in is accomplished by hand, is extremely simple in its workings, and is intended for moderate depths of water only. It is attached to the rail on the port side of the main deck, forward of the pilot-house. The Sigsbee machine can be used in all depths of water, down to the deepest parts of the ocean, and is worked by steam. It occupies a prominent position on the port side of the top-gallant forecastle deck (see opposite page). The principal accessories to sounding are the Sigsbee sounding-rod, with detachable weights; the Sigsbee water-cup; and the Negretti and Zambra deep-sea thermometer, with a new style of reversible metal case recently devised by Messrs. Bailie and Tanner of the fish-commission. With these appliances, samples of the bottom formation and water, and the temperature of the latter, can be obtained at each cast of the lead; and, by using a heavier sounding-wire (No. 18 wire gauge), several intermediate samples and temperatures are also procurable without much additional trouble.

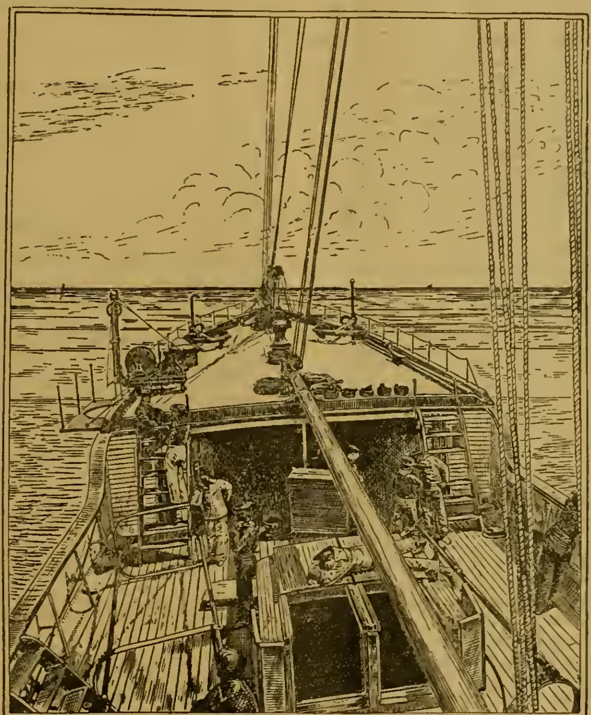


THE SIGSBEE SOUNDING-MACHINE.

The dredging appliances are as nearly perfect as are those for sounding, and comprise every improvement which has been hitherto suggested. Steel-wire dredge-rope measuring only an inch and an eighth in circumference replaces the old style of three-inch hempen rope, which is no longer recognized by deep-sea dredgers on this side of the Atlantic. The principal advantages of wire rope are its compactness, strength, and durability, and the ease and speed with which it can be handled. The working-reel of the Albatross, on which 4,000 fathoms can be stored at a time, occupies so small a space on the ship that its presence is scarcely noticeable.

The dredging machinery consists of a powerful hoisting-engine on the main deck directly in front of the foremast, and a reeling-engine and reel on the berth-deck underneath. A strong dredging-boom, thirty-six feet long, and pivoted to the foremast about seven feet above the deck, carries the dredge-rope clear of the vessel, and can be raised and lowered, or bent aside at any angle, to suit the convenience while dredging or trawling. Sudden strains on the dredge-rope are relieved by a Sigsbee accumulator, consisting of about thirty-five rubber car-buffers arranged for compression on an iron rod. This important accessory hangs suspended from the masthead above the hoisting-machine. The course taken by the dredge-rope while in use is as follows: starting from the reel on which it is contained, it passes through a pulley on the berth-deck to the drum of the hoisting-engine, thence up to and through an iron block at the lower end of the accumulator, and down again through a sheave in the heel of the boom, from which it extends to the outer end of the boom, where there is another large pulley. The free end of the rope is spliced into the eye of a set of safety-hooks, to which the dredge or trawl is fastened, and which are so arranged as to open and release the apparatus, should the strain, by reason of fouling on the bottom, exceed a certain amount. These hooks can be adjusted to detach at any point between three thousand and six thousand pounds, which is less than the tensile strength of the rope they are intended to secure from breakage. The amount of rope out at all times is recorded by a register attached to the sheave in the heel of the boom, the sheave measuring just half a fathom in circumference.

In preparing for work, the dredging-boom is topped up at the requisite angle over the starboard bow, and the loaded dredge or trawl is hoisted above the deck, on which stands the sieve or tubs ready to receive its contents. Two methods of sifting or washing the materials are followed. For the trawls, which generally bring up a heavy load, a large and deep square sieve, standing upon legs at a convenient height for working, is used. As the tail of the trawl is lifted above the deck,



FORWARD DECK.

the sieve is shoved under it, and the contents of the former are released. In case no washing is necessary, the specimens are rapidly transferred to their proper receptacles; but if, as usually happens, the load consists mainly of mud or sand, a stream of water from a hose is turned upon it, and it is thoroughly washed down. A nest of three or four small circular sieves, each having a different mesh, is generally employed for washing the contents of the dredges.

To describe the various appliances of research belonging to the outfit of the Albatross would carry us beyond the proper limits of this article: suffice it to say, that every method of obtaining results known to the fishermen and marine zoölogist will be tried. The scientific apparatus is mainly such as has already been thoroughly tested by American expeditions, and much of it has been described in published reports. There are many additional features, however, which have been lately added. The fisherman's outfit is complete, and comprises all kinds of seines and gill-nets, line-trawls, and hooks and line. The principal appliances for deep-sea research will be the dredges and beam-trawls, both in their original and modified forms; and, in connection with the latter, two large towing-nets will always be used. They are fastened, one at either side of the trawl, in the shape of wings, which name they now bear in the dredger's vocabulary. They were introduced as an experiment two years ago by the fish-commission; and, proving an invaluable adjunct to the trawl, they soon became a permanent fixture. The simple open towing-nets are to skim the surface of the sea at all times, when the speed of the vessel will permit; and occasional trials will be made with the Sigsbee trap for ascertaining the amount of animal life within any prescribed area below the surface.

The chemical department has not yet been completely furnished, but all the more important apparatus for making the principal tests, and glassware for saving water-samples, have been supplied. The photographic section has, however, been placed in perfect running-order, and affords the means of illustrating all sorts of objects, whether large or microscopic. It also contains improved appliances for registering the intensity of light at different depths.

Among the small boats with which the Albatross is liberally provided are two steam launches of the Herreschoff pattern for use in setting and hauling nets, and in spearing porpoises and large fish which cannot be reached from the high deck of the steamer.

From the above brief account, it may be rightly assumed that this new addition to our coast-marine is the most perfect floating workshop and laboratory for scientific purposes ever constructed. Its first cruise, during which it encountered severe winds, gave proof of its superior sailing qualities; and, judging of its outfit from past experiences, we are justified in predicting for it a long life of usefulness to science and the fishing interests. RICHARD RATHBUN.

SUN-SPOT OBSERVATIONS.

THE U. S. signal-service has published month by month since June, 1877, observations of sun-spots, made by Prof. D. P. Todd (now of Amherst college) with a telescope less than three inches aperture.

As a maximum of solar spottedness seems to have passed, it has been thought wise to collate these observations in the accompanying table, and present them for comparison and study.

In this table the Roman figures are the actual observed values, and interpolated values in Italic type are added for the sake of completeness.

The observations for August, 1878, were made by the Signal-service at Fort Whipple, Va. The mean monthly results combine both actual and interpolated values, and show that the last minimum epoch was at 1878.9, and the last maximum was at 1882.4.

Professor Fritz of Zurich gives the following table of maxima and minima of sun-spots for the present century to 1878. These agree in the main with the results of other researches.

Epochs of maximum and minimum sun-spots of the nineteenth century.

Maximum.	Period.	Minimum.	Period.
1804.2	12.2	1810.6	12.7
1816.4	13.5	1823.3	10.6
1829.9	7.3	1833.9	9.6
1837.2	10.9	1843.5	12.5
1848.1	12.0	1856.0	11.2
1860.1	10.5	1867.2	11.7
1870.6	11.8	1878.9	
1882.4			
Mean . . .	11.2	Mean . . .	11.4

Taking the mean of each twelve months, we have mean yearly numbers, in 1878, 2.2; 1879, 2.0; 1880, 14.3; 1881, 26.7; and, in 1882, 28.3. The last two agree with the observations of Tacchini in Rome.

Prof. D. P. Todd's sun-spot observations.

Day of month.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Mean daily observation.	No. of days.
1877.																																	
June	0	0	0	0	0	1	1	2	4	7	13	5	0	0	0	0	0	0	0	0	0	0	2	2	5	6	0	0	2	2		1.7	13
July	4	3	3	3	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	2	3	5	.9	20
August	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	8	8	8	7	6	2	2	1	1.8	19
September	0	0	0	0	1	2	4	6	9	10	7	6	4	6	5	5	12	14	18	10	6	10	5	0	3	3	2	1	1	2		5.1	19
October	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	7	10	12	30	2.1	16
November	30	25	20	12	8	2	0	0	0	0	0	0	6	14	11	8	5	0	0	0	0	0	0	0	0	1	3	6	9	9		5.6	12
December	9	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	3	2	0	0	0	1	2	3	4	1.2	15
1878.																																	
January	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	6	0	12	12	10	5	2	0	0	0	2 0	20
February	3	9	14	26	30	35	25	18	10	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				6.4	14
March	0	4	8	6	5	6	7	9	5	8	10	12	14	16	20	24	16	2	0	1	2	1	1	1	0	0	0	0	0	0	0	5.7	18
April	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		.7	19
May	1	2	0	0	0	0	0	0	1	2	1	1	0	0	0	1	1	0	0	1	1	0	1	2	3	7	13	18	18	20	22	3.7	11
June	24	26	28	12	5	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	8	8	6	4	2		4.4	15
July	1	0	0	0	0	0	0	0	1	2	3	2	1	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	.5	5
August	0	0	0	0	0	0	0	0	5	10	8	6	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.1	12
September	0	0	0	0	0	1	0	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		.2	13
October	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0		1	0	1	1	3	1	1	.4	19
November	1	2	2	1	1	1	1	1	0	0	0	0	0	0	0	0	1	0	1	2	1	0	0	0	0	0	1	0	0	0		.5	17
December	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	.3	10
1879.																																	
January	1	2	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	.3	13
February	0	0	0	0	0	1	0	0	0	0	0	1	0	2	2	1	0	0	0	0	0	0	0	1	0	0	0	0				.3	13
March	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	2	0	0	0	0	0	0	0	0	.2	17
April	0	0	0	0	0	1	0	0	0	2	3	3	4	8	14	10	8	6	4	2	1	1	1	0	0	0	0	0	0	0		2.3	17
May	0	0	0	0	0	1	3	4	4	3	2	0	0	2	4	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1.1	20
June	0	0	2	5	8	4	0	0	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	4	8	9	10		2.1	20
July	4	4	3	2	1	0	0	0	0	5	4	4	3	1	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1.1	19
August	0	0	0	0	0	0	0	0	2	4	8	14	8	2	1	0	0	0	0	1	0	0	7	12	10	8	11	10	7	3	3	3.6	19
September	3	2	1	1	1	1	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	1	1	1	2	2	2	2		.8	24
October	1	9	1	3	0	0	4	10	16	13	15	17	14	7	3	0	5	10	17	11	6	2	0	0	0	0	0	0	0	0	0	5.3	22
November	0	0	1	1	0	10	25	20	11	11	14	16	18	4	3	3	3	2	1	1	0	0	0	0	0	0	3	4	6	3		5.3	21
December	3	3	3	2	1	0	0	0	3	2	0	0	0	0	0	2	2	4	3	0	0	0	1	2	3	1	0	0	0	0	0	1.1	15
1880.																																	
January	2	5	15	24	22	15	16	16	20	24	22	20	26	30	20	18	12	10	7	5	2	1	0	0	0	3	4	4	0	3	9	11.5	17
February	14	14	11	11	11	11	11	18	18	13	8	6	4	0	0	0	0	1	2	3	3	6	6	3	6	1	1	1	2			0.4	19
March	3	5	3	1	1	2	2	0	1	4	3	1	0	0	0	1	2	2	1	1	0	0	0	0	0	2	3	4	5	8	9	2.1	18
April	10	12	20	26	16	10	3	3	5	10	10	10	10	13	13	8	3	3	3	4	6	6	0	0	4	8	18	25	12	2		9.1	23
May	20	20	20	17	12	10	14	13	12	8	8	4	2	1	1	0	0	0	0	7	2	3	4	8	20	22	25	26	28	29	27	11.7	18

Prof. D. P. Todd's sun-spot observations. — *Concluded.*

Day of month.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Mean daily observation.	No. of days.
1880.																																	
June	12	8	7	6	4	2	3	7	3	4	5	2	0	1	4	7	10	17	23	23	22	34	30	31	30	33	32	35	28	20		14.8	13
July	16	12	13	16	20	28	36	30	10	2	0	0	0	0	0	0	0	4	5	8	12	15	20	20	22	24	18	12	12	6	6	11.8	17
August	5	3	1	10	12	16	23	25	32	24	26	30	36	40	40	50	52	45	42	40	30	25	10	5	3	6	10	18	20	20	15	23.0	18
September	12	7	3	4	11	20	30	40	55	75	85	80	75	63	48	28	15	20	25	22	20	10	8	14	17	22	32	40	50	70		33.4	20
October	55	58	60	20	18	12	12	12	12	22	24	14	13	12	12	10	12	16	25	25	25	20	24	25	24	22	20	18	16	14	10	21.4	16
November	22	25	24	20	16	10	3	3	5	2	0	3	8	12	15	17	20	25	35	28	20	12	12	10	14	18	22	25	22	20		15.6	15
December	15	15	10	14	20	22	25	20	15	15	10	10	8	2	0	4	9	12	12	14	5	4	14	13	10	8	6	4	3	6	10	10.8	18
1881.																																	
January	10	11	12	13	14	12	11	10	8	6	4	3	2	4	6	10	15	20	18	16	10	3	8	20	28	35	50	55	56	55	50	18.5	13
February	45	35	25	25	25	40	40	35	25	15	15	10	10	12	17	20	25	20	13	22	18	16	12	11	10	8	4	3				19.9	19
March	6	8	5	1	1	3	4	12	22	35	45	47	50	85	85	85	80	70	55	40	45	60	60	40	15	9	2	3	4	5	7	31.9	21
April	8	10	20	20	20	18	14	12	10	8	7	11	15	20	40	47	55	65	75	90	115	100	85	60	58	55	35	10	7	5		36.5	16
May	6	8	12	14	15	14	13	18	18	18	17	20	22	13	8	8	6	4	2	1	4	9	16	26	30	37	44	56	48	60	65	20.4	22
June	60	55	50	45	35	20	9	15	22	30	40	45	47	48	50	40	33	25	15	12	10	5	10	17	25	40	50	57	65	60		34.5	14
July	45	40	35	25	35	25	27	30	35	35	30	25	22	20	19	20	15	13	15	15	15	20	25	40	65	60	62	65	65	62	60	34.4	24
August	50	40	35	25	19	25	25	26	20	20	15	10	8	3	0	0	8	4	8	5	6	10	35	50	60	70	80	110	120	120	110	36.0	22
September	100	85	70	55	40	30	25	20	20	15	20	25	30	30	25	20	25	25	20	15	12	10	8	5	3	4	7	9	9	9		25.7	16
October	9	20	35	30	20	25	25	20	20	20	18	17	16	15	14	12	13	14	15	25	45	40	40	35	30	25	18	16	14	12	10	21.5	16
November	8	6	4	2	2	3	6	9	15	20	20	20	18	20	20	35	35	34	35	35	36	35	33	30	22	21	20	18	15	17		19.8	12
December	25	30	32	34	35	30	28	25	30	35	30	35	30	27	26	25	20	17	12	10	9	8	6	12	9	9	10	12	12	12	15	21.0	16
1882.																																	
January	15	15	15	17	20	17	15	15	15	12	14	16	18	20	20	16	12	18	20	18	15	12	12	11	14	17	20	22	25	20	19	16.6	18
February	18	15	20	25	30	35	37	35	42	50	60	55	57	60	60	55	45	30	25	20	15	20	25	20	20	10	10	5				32.1	19
March	10	20	25	25	30	35	30	30	25	22	20	20	20	23	24	24	25	20	35	35	32	30	30	30	30	25	20	15	20	35	30	25.6	17
April	30	40	40	40	41	43	45	45	45	50	57	65	55	60	70	85	125	160	140	125	110	95	60	20	14	12	11	12	9	8		57.1	16
May	12	20	20	18	20	25	33	44	55	55	60	65	70	75	80	85	90	90	90	90	62	35	20	10	6	3	3	4	5	4	6	40.5	19
June	2	7	8	7	6	6	5	11	19	25	27	28	35	37	40	50	52	55	55	50	45	40	35	25	30	35	35	35	35	40		29.3	22
July	38	35	40	32	25	12	5	0	0	15	30	25	30	40	45	40	35	35	35	35	37	40	32	25	25	20	25	30	15	20	25	27.0	23
August	25	21	17	12	10	5	3	7	10	10	10	10	10	8	7	2	2	10	20	35	35	40	35	30	30	20	17	15	20	10	10	16.0	23
September	17	25	35	45	45	40	35	20	20	20	16	12	16	20	25	27	31	35	35	35	37	28	25	25	24	20	21	25	30	30		27.1	18
October	45	45	50	40	40	30	5	2	0	2	5	7	9	12	17	26	35	45	47	50	50	47	41	38	35	25	20	19	18	20	25	27.4	21
November	85	35	35	30	25	20	25	30	25	25	27	30	25	24	20	15	17	21	25	30	35	40	35	30	27	25	35	35	35	25		28.0	17
December	10	10	0	5	6	8	8	8	15	17	19	20	19	15	10	30	28	25	20	15	10	14	8	6	4	2	4	10	15	12	10	12.4	14
1883.																																	
January	8	6	2	4	6	7	8	7	5	6	6	12	16	20	30	28	27	25	23	20	18	20	15	10	8	8	7	4	2	6	14	12.2	11
February	20	20	20	17	15	22	30	25	25	25	31	45	55	45	35	25	20	20	15	10	6	3	0	2	3	4	7	7				19.7	20
March	6	5	3	2	0	2	4	6	10	15	10	6	4	8	12	17	20	20	20	15	20	25	30	30	25	30	27	25	24	22	21	15.0	17
April	20	22	25	30	35	32	30	30	25	20	25	35	40	60	67	70	67	05	65	55	55	45	40	30	20	20	15	12	10	8		35.8	21
May	10	7	10	9	8	7	9	9	11	14	12	0	7	12	11	10	11	11	12	11	10	8	4	2	0	0	0	0	1	1	4	7.4	23

Plotting the monthly numbers, it will be seen that there are plain indications that the maximum has passed, though it is thought by some that it is still to come. H. A. H.

FIFTEENTH ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS. — I.

The members of the society began to assemble in Chicago as early as Thursday, June 14, to visit the exposition of railway appliances, and to take part in the excursions planned for their benefit by the Engineers' club of the north-west.

By Monday morning, June 18, the number of those intending to take the special train for St. Paul, generously tendered by the officers of the Chicago, Milwaukee, and St. Paul railway, had swelled to three hundred. The train of eight cars, well filled, left Chicago at 7.30 A.M., arriving at St. Paul at 10 P.M. But few stops were made on the way, the principal one being at the crossing of the Wisconsin River, for the object of inspecting the railway bridge, and taking a better view of the fine scenery at that point. Quite an accession to the party came on board at Milwaukee.

Upon reaching St. Paul, an engine of the St. Paul, Minneapolis, and Manitoba railroad was attached; and the train was drawn over that line, through Minneapolis, to Lake Minnetonka, — a beautiful sheet of water some thirty miles long, where, at Hotel Lafayette, thirty-three miles from St. Paul, the members of the society and their invited guests were to be quartered during the convention.

The two cities of Minneapolis and St. Paul, only a few miles apart, and each containing over eighty thousand inhabitants, were rivals for the opportunity of entertaining the society; and to prevent any ill-feeling, as well as to avoid crowding any of the city hotels, already taxed to accommodate their own patrons, this summer hotel, just opened for the season, only built one year, newly enlarged and furnished, and capable of providing for the comfort of five hundred or six hundred guests, was chosen for headquarters. With the exception that some valuable time was lost in going to and returning from the place of holding the daily sessions, this selection is to be commended; for the location was extremely pleasant, and the air fresh and cool. Those who did not desire to go to the meetings each day could find rest and enjoyment at this agreeable summer resort. A special train was at the service of the convention each day throughout the entire week. A large accession to the number of members present was made as the week progressed, so that the attendance was larger than at any previous convention.

On Tuesday morning the engineers took the special train for St. Paul, and thence went to the state capitol, where the first meeting was called to order in Representatives' hall. After formal announcements of programme and arrangements, the usual addresses of welcome were made.

The first paper read was by the late Major F. U. Farquhar, U.S. eng., on the building of the dike for the preservation of the Falls of St. Anthony.

The falls, which furnish the water-power for the mills of Minneapolis, were first described. A stratum of upper magnesian limestone, eleven feet thick at the lower edge, is underlaid by an extremely soft sandrock, which is rapidly worn away; and the limestone is thus undermined and broken off. The recession of the falls was rapid; and, as the limestone outcrops with a thin edge twelve hundred feet above the present brink of the falls, their final reduction to rapids would occur, if not prevented. Citizens dug a tunnel for a tail-race in the sandrock, and the river broke in at the upper end. The immediate destruction of the falls was imminent; and attempts to check the rush of water, which rapidly enlarged the tunnel and repeatedly broke through in different places, proved ineffectual. The citizens, after building cofferdams at various weak points, discouraged by failures at times of high water, obtained an appropriation from the U. S. government, on the ground that the wearing-away of the falls would injure navigation above. A plan was finally proposed by Major Farquhar, of excavating a tunnel across the entire river, through the sandrock, from the limestone overhead to the sound rock below, some forty feet, and filling it solidly with concrete. This work was carried out under his direction, and was fully explained in the paper, and illustrated by drawings. The dike is eighteen hundred and seventy-five feet long, and has successfully shut off the water which worked its way through the soft sandstone. The detailed statement and cost can be found in the Report of chief of engineers, U.S.A., for 1879. The action of the water has been injudiciously concentrated upon a limited space of some three hundred feet by the erection of wing-dams by the mill-owners.

In the discussion on this paper at the time of its reading, and in remarks made the next morning by the engineer officer now in charge of the falls, the other works of preservation — the timber apron, the rolling dams above, and the crib which had been placed below, the falls — were described and commented upon.

Dr. C. E. Emery read a short paper, and submitted a table, showing the cost of steam engines and boilers complete, and the cost of operating the same for three hundred and nine days in the year, including repairs and renewals, and giving, upon the data assumed, the total cost per horse-power maintained continuously. He pointed out why small engines were comparatively more expensive to maintain than were large ones. The discussion of this paper was postponed until the next day.

The convention re-assembled at the state capitol on Wednesday morning. The discussion of Messrs. Farquhar and Emery's papers was first in order. The question was asked whether the amount expended in the preservation of St. Anthony's Falls would not have sufficed to establish and maintain an equivalent plant of steam-engines. Dr. Emery thought not.

Prof. T. Eggleston followed with a paper on 'An accident to steam-pipes arising from the use of blast-furnace wool.' He attributed a corrosion and subsequent explosion of steam-pipes at Columbia college to the setting-free of sulphur from the wool by the action of extremely diluted solutions of organic acids and the rapid corrosion of the pipe by the sulphuric acid, sustaining his position by reports of analyses and tests.

He was strongly opposed by Dr. Emery, who claimed that the corrosion was due to leakage and moisture, with alternate wetting and drying of the pipes, and that blast-furnace wool was entirely innocuous.

Mr. John Lawler of Prairie du Chien described the construction of the two pontoon draws in the railway-bridge across the Mississippi at that place. Each pontoon is four hundred and eight feet long, six feet deep, thirty-six feet wide on bottom, and forty-one feet wide on top. The interior details, the regulation of height of track, the means for fastening and for manoeuvring the draws, were described at length; and the cost was stated as one-sixth of the estimated cost of the usual iron swing-bridge. The bridge was built in 1874, and has been in continued use ever since. This bridge was seen from the train on the trip from Chicago.

The last paper at this session, by G. Lindenthal of Pittsburgh, Penn., was upon the rebuilding of the Monongahela bridge at that place, from his design and under his direction. The first portion of his paper entered minutely into details of the new structure, and was illustrated by tracings. The latter portion was occupied with a discussion of the old suspension-bridge, built in 1846 by John A. Roebling, the condition of the same before removal, the tests of the material removed, and the effect of the excessive overloading to which it had been exposed for years by the increasing and heavy traffic over the bridge.

After a brief discussion, the convention then adjourned; a portion of the members repairing at once to Lake Minnetonka, and the remainder going to Minneapolis, where visits were made to the Washburn flouring-mill and to the bridges.

(*To be continued.*)

KINETIC CONSIDERATIONS AS TO THE NATURE OF THE ATOMIC MOTIONS WHICH PROBABLY ORIGINATE RADIATIONS.[1] — I.

THE assumption that the mean kinetic energy of translation of the molecules of a gas is the measure of its temperature is one whose beautiful agreement with experiment has led to its acceptance as a necessary part of the kinetic theory of gases, and it has often led to the thoughtless conclusion that this translatory motion is also the mechanical source of the disturbances in the ether which originate radiations. But there are many difficulties in the way of accepting this view. One of the first, and perhaps the least, is the difficulty of conceiving how such a motion of translation, which is essentially longitudinal, can originate a lateral vibration, such as light and radiant heat must be.

A greater difficulty appears to be found in the extremely moderate mean velocity of translation which the molecules of a gas are found to have. Molecular velocities, which are of the same order of magnitude as that of sound or of a rifle-ball, seem hardly fitted to cause the necessary compressions or disturbances in a medium in which the rate of propagation is so immense; or, to state it in another way, if molecules, in describing their paths, originate radiations, then the motion of a rifle-ball ought also to do so, or, indeed, any much more moderate motion, such as that of a vehicle or animal.

A still further difficulty is, that there is another part of the kinetic theory which appears to be so related to this that both cannot

[1] Presented in abstract to the Section of chemistry and physics of the Ohio mechanics' institute, April 26, 1883.

be rigorously true at the same time, as appears from the following considerations. The most probable distribution of the component molecular velocities of a gas in equilibrium is the same as that of errors of observation. This distribution is brought about by fortuitous molecular encounters, and its permanence is insured by reason of them. But in case the progressive motion of a molecule gives rise to radiations, those molecules whose velocities are the greater are the hotter, and consequently radiate more heat to other molecules than they receive from them. They therefore lose part of their progressive energy before the next encounter. The whole effect would be to retard the motion of those molecules whose kinetic energy is greater than the mean, and accelerate those whose kinetic energy is less. This would cause a constant interference with the distribution of velocities according to the law of probabilities; and the interference would, so far as we are at present able to form an estimate of its amount, be sufficient to cause the kinetic energy of each molecule to approach indefinitely near its mean value during the time in which it describes a very small fraction of the mean path between two successive molecular encounters. If this is the case, the kinetic energy of any molecule does not differ for any appreciable time from its mean value, and is in effect the same during the whole path, so that there is no such distribution of velocities as has been assumed. In case the interference with the assumed law is not so complete as this, it must apparently exert an important influence upon the distribution of velocities, especially in the case of rarified gases, in which the encounters are comparatively infrequent.

Again: if the progressive motion of the molecules can originate radiations consisting of transverse vibrations, it would appear highly improbable that their rotary motion should not also do the same. But, as has been shown in a former paper,[1] the kinetic energy of translation differs from that of rotation for imperfect gases; and the temperature cannot be simply proportional to the mean rotary energy, though it might possibly be proportional to the sum of the rotary and translatory energies combined.

But aside from these difficulties, which may serve to show the intrinsic improbability of the supposition that the progressive motion of the molecules originates radiations, we seem to reach pretty decisive evidence against the supposition, when we consider the specific heats of solid bodies, or when we consider the nature of the radiation itself as revealed by the spectroscope.

The experimental law of Dulong and Petit, and the analogous results of Neumann,[1] show that in solid bodies we must consider the temperature to be measured more nearly by the energy of the atom than by that of the molecule. Now, it is hardly supposable that the translatory motion of a gaseous molecule should originate radiations, while that of a solid should not. We shall not, at this stage of the discussion, consider the spectroscopic evidence as to the nature of the motions which originate radiations, further than to notice that the characteristic spectra of gases appear wholly inexplicable, on the supposition that they are originated by translatory motions, with velocities distributed according to the law of probabilities, or with velocities reduced by radiation to an approximate equality, as it has been shown they might be; for even the simplest gases have spectra consisting of at least several lines.

If these reasons compel us to distrust the supposition that radiations originate in the progressive or rotary motions of the molecules, does the supposition that radiations originate in the vibratory motion, with respect to each other, of the atoms in the molecule, afford a better explanation of the facts? Such a motion, analogous to the elastic vibrations of a bell or other sonorous body, might very readily, perhaps, be shown, in case of a complex molecule, to have such a relation to the molecular encounters, and thus to the mean kinetic energy of translation, that its energy would be directly proportional to it for each given gas. In case this were established, such vibrations, considered as the physical cause of radiations, would explain the phenomena of gases as well as the supposition that they are due to the progressive kinetic energy; and they might possibly be shown to explain those of solids also.

But there is at least one difficulty, in the way of accepting this supposition, which seems insuperable in the case of monatomic molecules; for, if radiations could only originate in the vibrations of atoms with respect to each other within the molecule, monatomic molecules could not radiate heat at all, and could not have a temperature. That this should be true is not only inconceivable, but contrary to the known fact that monatomic mercury gas has a perfectly ascertainable temperature: hence

[1] An extension of the theorem of the virial, etc. — (*Sc. proc. Ohio mech. inst.*, March, 1883.) See also SCIENCE, i. 65.

[1] *Ann. phys. chem.*, xxiii. Wüllner's *Experimental-physik*, iii. 506.

the motions which originate radiations are not confined to such vibrations of atoms, even if it be possible that such vibrations do originate radiations. And this consideration leads us to what appears to be the truth of the matter, which is, that the atoms themselves are in a state of internal vibration. As will be seen subsequently, this internal vibration is, no doubt, accomplished under the action of internal forces, which permit extremely small deformations only of the atom by any external forces which can be brought to bear upon it; i.e., the modulus of elasticity of an atom is very large indeed, and very large, no doubt, when compared with that of the molecule. Indeed, if such vibrations exist within the atom itself, it is not difficult to prove that the force which binds the parts of an atom together (and consequently its modulus of elasticity) is much greater than the chemical force binding the atoms together into a single molecule; for it has been shown, in my paper upon the internal molecular energy of atomic vibration, that the amount of energy which can be imparted to a system like this is inversely as the modulus of elasticity. But chemical atoms are bodies which we are now supposing to be in internal vibration, but to which it has been found impossible to communicate energy in amount sufficient to cause them to fly to pieces. Since atoms do not become decomposed, while molecules do under various circumstances, it must be that their modulus of elasticity is much larger than that of molecules.

This view accords with that of Lockyer,[1] who has endeavored to explain the coincidence of lines in the spectra of different elements, and the relation of temperature to spectra, by the supposition that the so-called chemical elements are merely molecules which have never yet been decomposed by chemists. It must be admitted that the experimental evidence he adduces is of a very cogent character; and it seems to me that the demonstration by which I have shown that the mean energy of such a vibration would be extremely small explains how such a vibration can exist without decomposing the more complex atoms even at the highest artificial temperatures, though Lockyer has reason to think that they are decomposed in the hotter stars, where only the spectra of the elements of low atomic weight are to be found.

Were it true that every degree of freedom must have the same kinetic energy, we could not admit the possibility of such a vibration; for not only would such large amounts of energy be required by the degrees of freedom which seem certainly to exist between the atoms of complex molecules as to entirely contradict experimental values of the specific heat, but the supposition of additional degrees of freedom within each atom would require an amount of energy, on the whole, many times the actual specific heat of such bodies. But when the amount of energy required by such degrees of freedom is nearly a vanishing quantity, as I have shown, there is nothing to prevent us from assuming that to be the truth which spectroscopic evidence makes most probable.

We may notice, in passing, that the principle upon which this paper rests, that vibrations of this character can exist without absorbing an appreciable amount of kinetic energy, enables us to explain at the same time the extremely moderate rate at which exchanges of heat take place between bodies by radiation. They become only very slowly of the same temperature, which fact needs explanation in view of the extremely rapid propagation of radiations themselves. Now, according to our supposition, during a molecular encounter the molecules are roughly shaken, and there is a determinate distribution of energy to be found among the atoms, at its conclusion, in the form of internal atomic vibration, which distribution is due to the circumstances of the encounter. Those atoms which by chance have more energy than others radiate more rapidly; and since the velocity of radiation is so great, and the atomic distance so small, we may assume that the several atoms acquire almost instantaneously an energy of internal vibration sensibly equal to the mean, so that in a gas this is their condition during almost the entire free path of a molecule. In case the gas is becoming cooler by radiation to surrounding bodies, the atoms which radiate to these bodies lose more of their vibratory energy than they otherwise would, and thus have less mean energy of internal vibration than they should have under the law of distribution which determines what fraction this energy shall be of the mean kinetic energy of the molecules. At the next encounter, the atoms receive their proper share of the mean kinetic energy, which, being partially lost by radiation, is again supplied; and so on. And because this transformation into internal atomic vibration must take place before it can be radiated, and because at the same time the energy of this vibration is but an unappreciable fraction of

[1] Discussion of the working hypothesis, that the so-called (chemical) elements are compound bodies (*Nature*, Jan. 2 and Jan. 9, 1879). Necessity for a new departure in spectrum analysis (*Nature*, Nov. 6, 1879).

the total kinetic energy, the process of exchange by radiation is, on the whole, slow. Were, however, the translatory motion the direct cause of radiation, the exchanges between diathermous bodies must apparently be nearly instantaneous.

(*To be continued.*)

OYSTER-CULTURE IN HOLLAND.

THE first of a series of papers on the European oyster and oyster industry of the Eastern Schelde[1] has just been published by Mr. P. P. C. Hoek, secretary of the commission of the zoölogical station of the zoölogical society of Holland. It is to be followed by a series of papers gotten up in similar style by eminent specialists: 1°. On the embryology of the European oyster; 2°. On its food, parasites, and commensals; 3°. A review of the fauna of the Eastern Schelde; 4°. A report on the physical conditions presented by the Eastern Schelde; 5°. A report on experiments made to determine the conditions under which the fixation of the larval oyster occurs.

In this report the author devotes a short chapter to a discussion of the classical allusions to the animal, from the Homeric period to the time of Oppian. Then comes a chapter on the references to the oyster found in Conrad Gesner's *Historia animalium*, lib. iv., edition of 1620; followed by an exhaustive bibliography of ninety pages, in which the works of upwards of two hundred and seventy-five authors are mentioned, covering the period from 1685 to 1883, or nearly two hundred years.

Then follows a paper on the organs of generation of the oyster, by Mr. Hoek, accompanied by an excellent series of lithographic plates representing microscopic transverse sections of the European oyster. The text of this is in Dutch and French on alternate pages. A chapter is devoted to a historical *résumé* of our knowledge of the anatomy of the generative organs, and is succeeded by an account of the author's investigations.

A second part is devoted to the physiology of reproduction, and is preceded by an historical sketch of this part of the subject, from the time of Leeuenhoek to the present. The author gives a summary of his results, both anatomical and physiological, as follows: the genital gland is not a compact organ: it lies on the surface of the body of the animal under a thin layer of connective tissue (mantle), below which branched ducts spread out over the reproductive organ, connected on the inner side with the reproductive follicles, which have a generally vertical direction to the surface of the visceral mass, and which anastomose with each other. The generative products develop on the walls of the follicles, the ova and spermatozoa being formed side by side. The author inclines to the belief that the generative products are developed from the ectoderm. The ova are developed from single epithelial cells adherent to the wall of the parent follicle, while the mother-cells of the characteristic masses of spermatozoa are only portions of such cells. The organ of Bojanus does not have a compact structure as in other lamellibranchs, but is composed of a mass of ducts and blind sacs, which forms a thin flat plate of considerable extent. Contrary to what may be noted of the reproductive glands, the organ of Bojanus extends somewhat into the mantle. The ducts and cavities of the organ of Bojanus pour their contents into a longitudinal cavity, — the urinary chamber, — the walls of which are also excretory in function, and open outwardly by way of a short urinary canal. The external orifice of the renal organ opens into the same cleft as the genital duct, a little behind the latter, but they do not actually join. These genito-urinary sinuses lie below the adductor on either side of the ventral process of the body-mass. A reno-pericardiac canal connects the urinary chamber with the pericardiac cavity. It is probable that the auricles of the heart also exercise an excretory function.

An oyster which has fry in the branchiae is the parent of the same. At the moment of emission from the ovaries, not only have the ova been fertilized, but they have also passed through the first stages of segmentation. The sperm necessary for fecundation does not come from the same parent. The water which flows over other oysters in the vicinity charged with sperm, which they have set free, is carried into the mantle-cavity of egg-bearing individuals, and into their genital ducts and their branches. The oysters of the Eastern Schelde are two years old before they have brood; they are most prolific at the age of four or five years. There are more sperm-bearing oysters in the Eastern Schelde than egg-bearing ones. All of the mature eggs are laid at once; the production of sperm is probably continued for a longer time. In every instance that was investigated, the production and emission of ova is followed by a period during which no sperm is produced. A large proportion of the spat found fixed on the banks in the Eastern Schelde was probably not derived from the oysters inhabiting the cultivated beds. Culture appears to act injuriously upon the reproductive powers of the animal. In old oysters the liver is much more developed than in younger ones. This greater development of the liver is dependent upon the less marked development of the reproductive organs. J. A. RYDER.

[1] *Verslag omtrent onderzoekingen op de oester en de oestercultuur betrekking hebbende. Aflevering i.* (With title in French: *Rapport sur les recherches concernant l'huître et l'ostréiculture. Livraison i.*) Leiden, *E. J. Brill*, 1883. 253 p., 5 lithographic plates. 8°.

GALTON'S HUMAN FACULTY.

Inquiries into human faculty and its development. By FRANCIS GALTON, F.R.S. New York, *Macmillan*, 1883. 12 + 380 p., 6 pl. 8°.

MR. GALTON'S researches have for a good while attracted the attention of English and American students of psychology and anthropology. As they are here brought together, the practical purpose of their author is impressed upon us more clearly than ever. Mr. Galton means to introduce to our notice new aspects of the study of human character. He wishes to make this study more exact and scientific by founding it upon detailed investigations of facts previously neglected; and he proposes to offer the results as useful for a future science or art of eugenics, which shall teach the human race how to breed so that its best stock shall be preserved and improved, and its worst stock gradually eliminated. This seemingly utopian end is to be gradually approached by the formation of a public sentiment that shall encourage a new sort of family pride and exclusiveness; namely, when eugenic science has taught us what are the most useful human qualities, what their accompanying marks, what qualities are best transmitted to posterity, and what are the conditions that favor such transmission, then people otherwise not known to fame will be able, by a proper study of their family history, to discover their inherited wealth of valuable qualities, and their resulting eugenic rank; and such persons will be respected by an enlightened public according to their rank. People who rank high in the eugenic scale will be unwilling to contaminate their stock by unions with persons much lower in the scale, and their feelings in this matter will be appreciated. Thus marriages will become less blind, and civilization will progress faster.

That Mr. Galton's researches will be of much immediate use to young people about to marry, no truthful reviewer can promise; but to the psychologist, at least, they are in their present condition both attractive and useful; and, for the rest, it is much for Mr. Galton merely to have suggested, more definitely than Plato was able to do, that there ought to be, and some day may be, a real art of eugenics, which may be of practical importance for mankind. Just yet, neither Mr. Galton nor any one else can hope to do much more than to insist that the best parents may be expected to produce the best children; but there are many ways of insisting. Mr. Galton's most important contribution to this practical aspect of the subject lies in the facts that he has collected to give new importance to the matter by proving the vast predominance in ordinary cases of the influences of nature over those of nurture. Nature means for Mr. Galton the sum of all the inherited qualities of the individual, while nurture stands for the educating influences of the environment. In case of twins, Mr. Galton collects facts to show that in one strongly marked class of such persons the resemblance between the twins is very strong from the outset, and then often extends through life to the smallest possible matters of physical and mental condition, even when the twins live far apart. But in other cases, which form a second equally marked class, the twins, contrasting somewhat strongly from the outset, never are brought nearer to likeness, notwithstanding all the similarity of the circumstances of their nurture and training. Thus, when the physiological conditions of their origin give them like nature, difference of nurture does not prevent very striking similarity throughout life; while, where the conditions of origin favor unlikeness, likeness of nurture goes but a little way to overcome the contrast. A similar result is indicated, according to Mr. Galton, by our experience with races of animals, some of which seem by nature disposed to domestication, while the stubborn nature of others resists the advantages of any nurture, so that they remain wild, however much we may try to tame them. From whatever side, then, the matter is viewed, nature seems superior in its persistence to the forces of nurture that opposed this persistence; and, if we want human stock to grow better through voluntary effort, we must undertake to study and improve pre-natal and ancestral influences yet more than we try to better the influences of education.

This, then, is Mr. Galton's most significant practical result. His researches upon various problems of the science of character, that have not yet been long enough studied to have much immediate practical significance, cannot easily be summed up in one short notice. The psychologist is most interested in his researches on mental imagery and on association of ideas. Mr. Galton is of the opinion that introspection can be made a more exact science than psychologists have previously found it. And so, indeed, it can be, no doubt, at least when it is limited to the lowest orders of mental facts. Here introspection is greatly aided by plain and simple questions. Ask a man to tell you all he can about what now goes on in his mind, and he will answer as wildly as you could wish; but ask him to call up in mind the picture of his hat or of his house, or to tell you whether in some concrete instance he can vividly remember musical harmony as distinct from melody, and most honest men can then answer intelligibly and usefully. It is Mr. Galton's service to have shown how much can be done by thus systematizing and simplifying the method of introspection, so that people who are not psychologists may be able to furnish to the psychologist important and trustworthy data.

We do not remember that our author is quite plain in defining one of the safeguards needed to make this method useful. He says, in describing his researches into mental imagery (p. 87), "The conformity of replies from so many different sources, which was clear from the first, the fact of their apparent trustworthiness being on the whole much increased by cross-examination, and the evident effort made to give accurate answers, have convinced me that it is a much easier matter than I had anticipated, to obtain trustworthy replies to psychological questions. Many persons, especially women and intelligent children, take pleasure in introspection, and strive their very best to explain their mental processes. I think that a delight in self-dissection must be a very strong ingredient in the pleasure that many are said to take in confessing themselves to parish priests." But there is an obvious moral from all this. The method, with its questions and cross-questions, with its interested subjects and their pleasure in confessing themselves, is indeed fruitful; but the outcome must be controlled by the maxim that the subject's statements, when he is not himself an expert, must be trusted implicitly only when they are out of relation to any preconceived theory of his own about his mind, and equally out of relation to any popular prejudice or superstition that could influence him. Generally Mr. Galton seems to follow this maxim without explicitly recognizing it. The simplicity of his questions is itself a security. If you ask about one's mental picture of his breakfast-table or of his hat, you can be tolerably sure that he has no prejudices or superstitions that will affect his answer. But it is another thing, in case one is inquiring about the 'visions of sane persons,' and mentions some great man, say Napoleon, who is declared by some one to have had visions of his 'star,' and to have boasted thereof. Here such evidence as can be got would be worthless, even if the great man in question were not a notorious liar. For superstition, once for all, attributes stars to great men; and, when a story exactly corresponds to a known and wide-spread superstition, we may usually disregard the story save for the purposes of folk-lore. Yet, on p. 176, Mr. Galton makes a story of this sort the basis of reflections that of course may possibly be true; so that his caution is not quite perfect.

In fact, we should be disposed to apply the maxim just stated yet more carefully; namely, if the subject shows an uncommon visualizing power, he is both instructive and dangerous, and ought to be treated very tenderly. He can furnish many facts, but his replies are by so much the more apt to be influenced by some theory of his own. Accustomed all his life to his vivid imagery; very possibly a member of a family several of whom are uncommonly gifted in this respect; accustomed, therefore, to notice and talk about his power, and perhaps to boast of it, — he may have formed already some vain-glorious idea of what he can do or ought to do; and, when you set him at the task of talking about himself, you must be careful how you accept all that it may occur to him to say. A brief experience with one such subject as we have just described has convinced us that serious danger would arise from applying Mr. Galton's method to him without great care. And if we intended to publish any of his experiences, we should confine him strictly to commonplaces, should not publish his stories of what he used to see when a child, and should not introduce any thing that he connected with 'elevated spiritual experiences,' or with any other artistic excellence of which he seemed to feel proud. We fear that some of Mr. Galton's subjects needed more such watching. In fine, though Mr. Galton's researches on mental imagery, since their first publication in the form of memoirs, have greatly helped introspective psychology, no one, doubtless, would fear or deplore more than himself any misuse of them that should tend once again towards the mythological. Our suggestion is intended to help to ward off such a sad result, which, for the followers whom Mr. Galton is certain to have, might not be very far off. What might not our author have to mourn over, if 'psychological associations' were to become fashionable in country towns, and were to produce acres of manuscript or printed proceedings containing elevated spiritual visualizing experiences by old maids and semi-spiritualistic reformers? Yet, in these days of popular science and associations, who knows what Mr. Galton's pleasing way of speech might not produce, if he does not add to every new chapter of facts a note strenuously insisting that the exact and cautious methods that are commonplaces for him should be studied and followed by every ambitious one that would do likewise, however simple the subject-matter investigated may seem to be?

Mr. Galton can claim especial credit for his investigations into visualized number-forms. Here the nature of the facts is the best guaranty of their general accuracy. They have generally been unknown, save to the subjects; they are not things of which people are apt to boast; their psychological significance is far greater than their popular interest; they have nothing of the elevated or of the spiritual about them; the research is quite new. All this secures the substantial correctness of the results, though, plainly, further accurate research will become harder when Mr. Galton's facts become more popularly known.

One general result that Mr. Galton seems to have established is, that growth in the power of abstract thought is opposed to the free development of the visualizing faculty. Scientific men have, as a rule, less vivid imagery than persons of less abstract habits of mind. Adults visualize less clearly than children. But this loss of visualizing power does not signify, he tells us, loss of clear memory of details. "Men who declare themselves entirely deficient in the power of seeing mental pictures can, nevertheless, give lifelike descriptions of what they have seen." Again: "it is a mistake to suppose that sharp sight is accompanied by clear visual memory." Yet more: "the visualizing and the identifying powers are by no means necessarily combined." Thus our author tells us that one distinguished subject is good at recognizing faces, but cannot visualize them at all. All these facts, and many others, seem to us to point to a result that Mr. Galton sometimes approaches, but does not distinctly formulate. On the contrary, in one place he says something directly opposed to it. "A visual image," he says (p. 113), "is the most perfect form of mental representation, wherever the shape, position, and relations of objects in space are concerned." And he thinks that mere laziness is responsible for the common starvation of this faculty; but, if this were so, it is hard to see how a healthy mental organism should, in the course of its normal development, generally tend to outgrow the visualizing faculty. 'The most perfect form of mental representation' for any purpose will not be the one that we should, as evolutionists, expect to find growing naturally less as the mind devotes itself more to that purpose; yet who are more concerned with the exact relations of things in space than workers in the details of descriptive natural science? And they, we are told, are apt to lack the faculty in question. The statement just quoted seems, then, to lack probability, and to be against the main result to which, as we have said, all these researches seem to lead.

This result, we think, is that the clearest memory, in the long-run, tends to be the memory of acts, and not of the content of a sensation apart from its immediate relation to an action. This seems reasonable from the point of view of evolution. The life of an animal consists in doing what seems best under the circumstances; and the seeming is determined by instinct or individual experience, coupled with immediate sensation. All, then, that sensations mean for the animal, is summed up in saying that the sensation is useful as the sign of the need of a certain kind of action. The association of a given kind of sensation with a given kind of action results from individual or ancestral experience; but, in forming this association, not the whole of an experience need be remembered, but only so much as shall serve as a sign of a given sort of action. The mouse, even if it fled from the cat, not by instinct, but voluntarily, would still not need to visualize cats, but only to remember so much of the sensations aroused by a cat's presence as should suffice to arouse the right action.

On the other hand, if a given action is to be not automatic, but voluntary, the action must be conceivable clearly and in detail. If this is so, it will follow that the memory for ideas connected with muscular sensations, and so for actions, both bodily and intellectual, would not merely be capable of substitution for visualized images, but would normally tend to be so substituted. In fact, if a visualized image were the 'most perfect form of mental representation' for space relations, then geometrical reflection and definition would be a useless amusement in all cases of small objects. The other facts noted above, such as the relative power to identify without being able to visualize, seem to us capable of explanation in a similar fashion, by the relative preponderance of the memory for actions, and consequently of relations (which we know by virtue of our own bodily and mental actions), over the memory of the contents of bare sensation.

But we have said nothing of Mr. Galton's composite photographs, of his researches on association, or of the many other topics that render his book not only very amusing, but especially instructive, as showing how what in the hands of another man would be mere dilettanteism becomes in the hands of the master a very valuable series of contributions to science. And with these suggestions we must leave a very pleasant topic.

STOWELL'S MICROSCOPICAL DIAGNOSIS.

Microscopical diagnosis. By CHARLES H. STOWELL, M D., and LOUISA REED STOWELL, M.S. Detroit, *G. S. Davis*, 1883. 8+93+118+35 p., 10 pl. 8°.

THE title of this book led us to expect a work specially referring to the applications of the microscope in medical practice, and we felt that a good book of that scope would be welcome and valuable. As in the opening sentence of the preface Professor Stowell says it has been his good fortune to be so situated, during the past few years, that his entire time has been devoted to the study of histology and microscopy, with special reference to the microscope in its relation to the practice of medicine, our anticipations seemed confirmed, and the expectation added, of finding much new and original matter. An examination of the body of the book was disappointing, because it gave us acquaintance with contents so miscellaneous and varied that we were reminded of those so-called 'happy families' where discordant associates live in compulsory peace, — something quite unlike a natural and well-proportioned assemblage.

The first eighty-two pages alone deal with clinical microscopy, and we think not satisfactorily; for the treatment is hurried and incomplete, though certainly accurate, what there is. The best part is the few pages on urinary deposits, with the accompanying admirable plates by Mrs. Stowell. The portion on parasites and tumors is extremely inadequate. The three specimens of Demodex figured, must have encountered some frightful disaster before they were drawn. We regret, that, instead of all this, the author did not prepare a translation of Bizzozero's *Manuale di microscopia clinica*.

The bulk of the book is made up of botanical articles, by Mrs. Stowell, on starch, wheat, and various medicinal plants. These are pleasantly written, and the illustrations display the authoress's skill in drawing; but we miss in these, as in the other parts of the volume, any definite purpose, either of text-book writing or original research. In this connection, we are impressed by the absence of references to scientific literature.

Part iii., by Mr. Walmsley, describes the methods employed by him in the commercial manufacture of microscope slides. It is extremely elementary, and the methods most employed in scientific biology are in large part unmentioned. The same subject of methods has been far better treated by numerous previous writers.

In short, we are quite at a loss to discover the *raison d'être* of this pleasantly and clearly written, as well as beautifully illustrated work. The new and original matter which we looked for, after reading the preface, we have not found; yet the facts and figures seem all to rest upon personal observation.

To the amateur microscopist, the book may well serve as a guide to certain things not elsewhere so well described.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Classification of surfaces. — In a memoir contained in the Abhandl. kön. akad. wiss. zu Berlin for 1868, M. Christoffel treated of the classification of surfaces by formulating the changes which took place in a geodetic triangle on the surface when it was displaced or moved along on the surface. M. Christoffel was thus led to a classification of surfaces which divided them into four groups. The first group contained all surfaces upon which no displacement of a geodetic triangle could take place without altering the triangle; the second group contained surfaces upon which a geodetic triangle might be displaced without alteration, provided its angles moved upon certain determinate curves; the third group contained surfaces upon which the geodetic triangle might be displaced without alteration in a singly infinite number of ways; and the fourth group contained surfaces upon which the triangle could be displaced in any manner without alteration. In the present paper, M. v. Mangoldt revises this classification, and shows that the surfaces contained in the third and fourth groups are identical, and that they include all surfaces with a constant measure of curvature, and only these. Also he shows that the second group contains all surfaces which are developable upon surfaces of rotation which have not a constant measure of curvature, and only these. The author further revises a paper of Weingarten's, correcting an error which appeared there. — (*Journ. reine ang. math.*, xciv. i.) T. C. [74

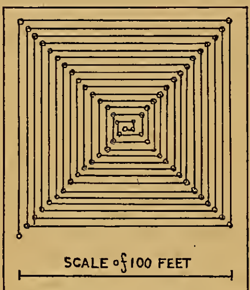
PHYSICS.

Electricity.

Aurora borealis. — Professor Lemström has now given a somewhat detailed account of his apparatus and experiments in Lapland. He and others had years ago in that country observed a pecular luminosity, which he calls 'phosphorescent,' in the form of 'tiny flames' playing about the tops of small mountains.

As long ago as 1871 an attempt was made to assist the production of the aurora upon these hilltops; but the results obtained were not, to scientific men in general, entirely satisfactory. Accordingly, in 1882, Prof. Lemström prepared to repeat his experiments upon a more extended scale.

Upon the top of Oratunturi Mountain (lat., 67° 21′; long., 27° 17′.3 east of Greenwich), about 540 meters above sea-level, he laid out, upon insulators raised about 2½ m. above the ground, a bare copper wire in the form shown in the illustration, the wires being about 1.5 m. apart. The area covered in this way was about 900 square metres. The single wire which made up this spiral was provided with numerous points soldered on; and the inner end was connected by an insulated line with the observing-station at the foot of the mountain, where the circuit ran through a galvanometer and into the earth.



ARRANGEMENT OF WIRES.

From the day the apparatus was finished, viz., Dec. 5, "there appeared almost every night a yellowish-white luminosity around the summit of the mountain, while no such luminosity was seen around any one of the others! The flames were variable in intensity, and in constant oscillation as those of a liquid fire. Three times it was tested, 2½ miles off in south-east, by a Wrede spectroscope (small size with two prisms), and it returned a faintly continuous spectrum from *D* to *F*, in which the auroral line $\lambda = 5569$ with soft variable intensity was observed." The galvanometer, meanwhile, showed an extremely variable positive current from the wire at the top of the mountain to the earth.

An attempt was made to determine approximately the electromotive force of this current by occasionally introducing into the circuit a Leclanché element, and observing the change thus produced. As the insulation of the line leading up the mountain was not good, however, we must accept with caution, as Prof. Lemström admits, the results thus obtained. The current from the mountain top was apparently sometimes less, and sometimes considerably greater, than the Leclanché element produced.

Similar results were obtained at Pietarintunturi Mountain (950 metres above the sea, in lat., 68° 32′.5; long., 27° 17′.3 east of Greenwich), where a smaller spread of wire was used.

There seems to be very little doubt that Prof. Lemström has succeeded in producing the aurora at will, or rather in assisting nature to produce it. Some of the conclusions which he draws from his experiments, however, will, no doubt, be received with caution, not because they set forth any thing in itself improbable, but because the experiments described seem too few and rough to decide the matter beyond a doubt. Thus he believes that "the *electricity* which descends into the auroral belt [the circumpolar belt of maximum auroral activity] is the *primary* cause of the greatest part of the terrestrial current, and, through this, of the variations of the magnetic elements." Moreover, finding that in several cases observers in different stations were near mistaking different auroral arcs for the same one, he concludes that "*all* measurements of the height of the aurora, calculated on those with a long base north and south, are always erroneous, as the two observers *never* see the same aurora. And even those calculations which are based on the measurements of the height and length of an arc from one point, and the hypothesis that the arc extends around the magnetic pole, must be considered very unreliable, as no satisfactory answer can be given as to what results would have been obtained a little farther north or south. This is also the case with aurorae with long bases east and west," etc. He says, therefore, "That the height of the aurora borealis is very variable I fully admit, but in my opinion it has been greatly over-estimated."

It seems probable that a great many people incline to a similar opinion,[1] and will merely regret that Prof. Lemström has not given them some better foundation for their disbelief. For many years, however, the doctrine has been current that auroras frequently exist at a height of a hundred miles or more; and the substance of Prof. Lemström's present arguments against such a belief must have been old for a long time.[2]

On several occasions it was observed by Prof. Lemström's party that the peculiar spectroscopic auroral line "was returned from every quarter of the horizontal plane, (and) even from the zenith, *without any aurora being visible.*"

Another phenomenon of much interest is a "peculiar phosphorescent 'shine,' or diffused luminosity, which possesses several phases, but the general character of which is a luminosity of a yellow-white color, which renders the night as light as the moon with a thick hazy air." On one occasion "every object around stood out clearly in a yellow-white hazy phosphorescent luminosity of quickly-shifting intensity." Apparently no spectroscope was at hand at this time; but on another night, when a similar 'shine,' less bright, but still sufficient to nearly obscure the stars upon the horizon, was seen, an attempt to discover the auroral line was unsuccessful. It is true that the spectroscope used was not well

[1] *Proc. roy. soc.*, 1879–80, xxx. 332.
[2] *Amer. journ. sc.*, xxxix. 286.

adapted for the purpose; and Prof. Lemström attributes the phenomenon to the same origin as the aurora.

Prof. Lemström refers to Groneman's meteoric theory of the aurora, and no doubt considers it to be disposed of by the experiments above described. It happens, however, that the same number of *Nature* contains an article from Dr. Groneman, in which he says, "I believe I have proved by this research that there existed with the aurora of Nov. 17, 1882, cosmic dust, passing through the upper strata of our atmosphere with great velocity, and giving, according to the most interesting observation of Mr. Rand Capron, 'the usual green line' of the aurora spectrum;" and, further, "It is very remarkable that this experiment comes at the same time as the interesting experiment of Prof. Lemström, showing that electric currents are able to give a development of light in our atmosphere, possessing the same number of undulations in a second as the auroral light. Now our meteoroid being part of an aurora, it gives a stronger proof of the origin of that phenomenon than Prof. Lemström's experiment, the greatest attraction of which is that we are able to repeat it arbitrarily and with our own means. Further, I have always maintained that electricity, excited easily by friction, must be one of the causes of the auroral light . . . and it seems to me very plausible that cosmic matter, approaching the earth, induces electric currents through the air. Therefore I think that the results of Prof. Lemström are in full harmony with the idea of a cosmic origin of aurorae." — (*Nature*, May 17, 31, June 7.) E. H. H. [75

CHEMISTRY.

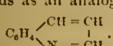
(Organic.)

A new acid occurring in the juice of the beet. — E. O. Lippmann claims to have discovered a new acid in the incrustations which form in the evaporating-pans from the juice of unripe or partially decomposed beet-roots. Analyses gave results corresponding to oxycitric acid

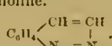
$$\left(COOH-CH_2-C\frac{OH}{COOH}C{}^{H_2}_{COOH}\right),$$

obtained by Pawolleck by boiling chlorcitric acid. — (*Berichte deutsch. chem. gesellsch.*, xvi. 1078.) C. F. M. [76

Cinnoline-derivatives. — V. v. Richter found, that, by warming an aqueous solution of the diazo-chloride of orthophenylpropiolic acid, a carboxylic acid of *cinnoline* was formed, a substance which he regards as an analogue of chinoline.



Chinoline.



Cinnoline.

— (*Berichte deutsch. chem. gesellsch.*, xvi. 677) C. F. M. [77

Compounds of the ketones with hydrazine. — The action of phenylhydrazine upon ketones seems to be analogous to that of hydroxylamine. With acetone, H. Reisenegger obtained the compound $C_6H_5N_2HC(CH_3)_2$, which was decomposed, by warming with dilute acids, into acetone and phenylhydrazine. Acetophenonphenylhydrazine resulted from the action of phenylhydrazine upon acetophenon. Oenanthol gave the substance $C_6H_5N_2HC_7H_{14}$. With dimethylhydrazine, acetophenon formed chiefly $(CH_3)_2N_2C{}^{C_6H_5}_{CH_3}$. — (*Berichte deutsch. chem. gesellsch.*, xvi. 661.) C. F. M. [78

METALLURGY.

Sulphuric acid from pyrites. — There are very evident advantages in using pyrites instead of brimstone for the manufacture of sulphuric acid, provided the right kind of pyrites is at hand. The qualities necessary are a high per cent of sulphur and iron, in order that the cost of handling may be a minimum. Lead, zinc, calcium, and magnesium can only be present in very small quantity, as they will roast to sulphates, and so cause a loss of sulphur; moreover, they lessen the value of the iron as a by-product. Copper to the amount of two or three per cent is found in some of the best pyrites for this purpose, and is extracted as a by-product. But the especial element to be avoided is arsenic, both on account of the rapid corrosion of the chambers, and the rendering of the acid unfit for many uses. The cost of a ton of oil of vitriol made from brimstone is estimated at \$13.58; made from pyrites, at \$8.22. A number of localities in America furnish pyrites of good quality. The only alterations in the plant are the addition of a Glover tower, and the substitution of suitable kilns, of which illustrations are given, as well as of the Schaffner shelf-burners. — (*Eng. min. journ.*, May 5.) R. H. R. [79

The Henderson gas-furnace. — This furnace attempts to attain to the highest heats required in the shortest possible time, and with a complete utilization of the fuel. These objects are reached by the use of separate engines, one for the supply of air for the generation of the gas, and the other for its combustion. The details of a trial and illustrations of the furnace are given. The consumption of fuel, three hundredweight per hour for the two-ton furnace, is low. — (*Eng. min. journ.*, May 19.) R. H. R. [80

GEOLOGY.

The mines of Cuba. — Salterain gives a brief account of the mines now worked, or that have been worked in the past, at least so far as known by the general inspection of mines. The 'minas de asfalto y de aceites (oils) bituminosos' are divided into mines of asphalt, of petroleum, and of naphtha, and number seventeen in all. The prospects are considered favorable, about eleven or thirteen hundred tons being produced annually. They are situated mostly in the provinces of Pinar del Rio, Matanzas, Santa Clara, Pto. Principe, and Habana. The copper-mines are thirty in number, almost all situated in the province of Santiago de Cuba, and a few in Santa Clara. The mineral consists of veins of sulphate of copper, oxide of copper, native copper, carbonate of copper, and indications of copper pyrites, all of which, at a certain depth, are supposed to unite in one vein of sulphate of copper. The iron-mines, seventeen in number, are all situated in the province of Santiago de Cuba. The iron consists of large superficial masses of oligist and magnetic iron ore. Manganese is very abundant in the province of Santiago de Cuba, but only two mines have been registered on account of its small commercial value. There are five gold-mines situated in the provinces of Santiago de Cuba and Santa Clara, whose prospects are considered good, but which are not worked at present. Guano is worked in the islets south of Cuba, and 104 workmen were employed on this work last year. — (*Breve reseña miner. Isla de Cuba.*) J. B. M. [81

The Prescott (Arizona) mining region. — A map of this region, with some account of the rocks and veins, has been published by John T. Blandy. The rocks appear to be mainly granites, argillites, and schists. The majority of the veins trend approximately north and south. In the stratified rocks many veins occur having the strike and dip of the enclosing rock, but they are of limited extent. In the Peck district the veins are of quartz, carrying silver in the form of chlorides, sulphides, and in galena. The argillite has been eroded away so that some of these veins stand as much as fifty feet high, while they are not more than six feet thick at the base. In the granite ridge next north, the veins are quartz and barite, carrying silver, while in the gneissoid rocks they are part silver and part gold bearing. The veins in the Mount Union granite are principally gold bearing, the gold being free on the surface, but in pyrite in depth. The chief portion of the remaining veins in the region are mixed gold and silver bearing, some being as much as thirty feet in thickness. Some veins of copper pyrites also occur. — (*Trans. Amer. inst. min. eng., Boston meeting.*) M. E. W. [82

GEOGRAPHY.

Russian cartography. — M. Michel Venukoff presents frequent brief reports of Russian explorations and topographic work to the French geographical society, and has recently described the annual exhibition of astronomical and geographical works held last April in the Winter palace at St. Petersburg. The number of exhibits exceeded one hundred and forty, among which the more notable were a route-map of Russia in Europe (1 : 1,050,000), in twenty-five sheets, of which seventeen are finished; the latest sheets of the special maps of the same country (1 : 420,000), published under the direction of Gen. Strelbeitsky; the general map of Russia in Asia (1 : 4,200,000), in eight sheets, extending to lat. 30° N; maps of the provinces of Finland and Bessarabia; of the peninsula of Kamtchatka, prepared at Irkutsk; of the territory of Semipalatinsk, lithographed at Omsk; the Chinese and Persian frontiers (1 : 840,000); and many others of regions concerning which our chief knowledge comes from Russian surveys. — W. M. D. [83

(Arctic.)

Notes. — Professor J. E. Nourse of Washington announces that he has in preparation a work relating to American polar expeditions. —— The Russian imperial geographical society of St. Petersburg suggests that the observations of the international polar stations be prolonged over another year, on the ground that a single year's observations cover too short a time to afford really satisfactory comparative results; and, moreover, it will be necessary for some of the more advanced parties to make an end of their observations before the full year is out in order to be sure of returning during the present autumn. —— Reports from Bering Sea indicate that the winter there has been a severe one. Early in the spring there was an abundance of ice as far south as St. Paul Island. Very few whales had been taken up to latest advices. —— The report of the court of inquiry into the circumstances of the loss of the Jeannette and the death of members of the expedition is just printed. It does not contain the private journals of De Long and Collins, nor the papers of the latter which were before the court. The text of the report has been mostly summarized by the daily press, and contains nothing new of importance. It is presumed that the log-books, and records of observations, etc., are reserved for a report on the results of the voyage, to be hereafter issued. The most valuable thing in the whole document, which contains a number of maps and diagrams, is the map of the Lena delta constructed by Nindemann, which contains additions to and corrections of the maps in present use. — W. H. D. [84

(Asia.)

Notes. — The Revue géographique presents its subscribers with a new chart of Asia on a scale 1 : 34,000,000. Although containing some new matter, it is not up to date, and is of very imperfect mechanical execution. —— The Russian explorer Konchin telegraphs from Krasnovodsk, that, in crossing the steppe between Charzhui and Uzboi, he has discovered that Kalitin was mistaken in supposing it to be traversed by an ancient channel of the Oxus. What the latter explorer, three years ago, took for the dry bed of the Charzhui-Daria, is really only a plain bounded on the north by a series of elevations, and appearing to have no definite limits toward the south. —— Potanin and Skassi are about to explore the Chinese province of Gan-su and the adjacent parts of Mongolia. Sukhacheff, a young proprietor of Siberian gold-mines, has contributed 20,000 rubles toward the expenses of the exploration. —— The topographic and geodesic work in northern Khorassan and southern Turkestan being finished, the boundary-line between Russia and Persia from the Caspian to the Heri Rud River of Afghanistan will be established immediately. —— The definite establishment of the boundary between the Russian province of Semipalatinsk and the Chinese district of Tsungari will also be concluded this summer. By recent conventions a considerable part of the basin of the upper Irtish River is annexed to Russia. Topographers are busily engaged in determining its limits, while others continue the work of demarcation of the districts of Kuldja and Tarbagatai, which is already well advanced. Still others are developing the official limits between the basins of the Syr Daria and the Tarim rivers. — W. H. D. [85

Oxus and Caspian. — A recent report on the levellings undertaken by the Russian engineers to determine if the Oxus (Amu-daria) could be turned from its present channel, which leads to the sea of Aral into the Usboi channel, leading to the Caspian Sea, decides that it is impossible without extended artificial works. A canal would have to be constructed for a length of over two hundred versts, at a cost of at least fifteen to twenty million rubles, before it would be possible to divert the Oxus from its present course. — (*Peterm. geogr. mitth.*, 1883, 231.) W. M. D. [86

(*Africa.*)

Notes. — Joseph Thompson's party has been heard from, having been obliged to retreat to Mombasa, on account of hostilities excited by a caravan in advance of them. All well, and would make another start with a different caravan. —— Schweinfurth has made a scientific journey from Cairo to Mirsa Tobruk in Cyrenaica. —— News has been received from the delayed Italian expedition to Abyssinia and the coast of the Red Sea, according to which the principal official party are detained at Debra Tabor by King John, while the explorer Antonellé has succeeded in getting away from Assab and in travelling through the Aussa country, previously closed to Europeans, to Schoa. —— Dr. Pogge has returned to Mukenge, according to a letter forwarded by Portuguese traders from Malange, and will shortly depart for Europe. —— The German traveller Flegel has returned to the coast from his journey in Adamaur. —— The British government has annexed the territory lying south-east of the former limits of Sierra Leone as far as the Liberian boundary, between that and the Sherbro Islands. —— Several French trading-stations have recently been established on the Futa Diallon coast, northward from Sierra Leone, in the hope of opening a lucrative traffic with the rich interior districts. —— The French naval surgeon Colin has been intrusted with a mission to the old gold-country of Buré on the upper Senegal. —— The Morocco authorities have permitted Spain to undertake a topographical investigation of the country around Santa Cruz de Mar Pequena, on the coast opposite the Canary Islands. —— The khedive has appointed the minister of the interior and former governor of the Soudan, Eyoub Pacha, to the presidency of the Société de géographie de Cairo. The general secretary Is Dr. Bonola. —— The credits granted for the Algerian administration, by the commission to revise the estimates, amount to about twenty-eight and a half million francs, of which about three million francs are for purposes of colonization. The imports into the colony from all sources in 1880 were about eighty millions, and the exports about fifty-six millions. The customs receipts from all sources were about ten million francs. —— Lieut. Angelo Cardozo of the Portuguese navy has just returned from Mosambique, where he has been eight months engaged in explorations in Sofala-land. He ascended last September from Inhambane toward Mulamula and Pachano, along the mountains to Maringua, and across the Sabia River to Goanha; thence, descending the Gorongoza to Sofala, he returned to Inhambane by the seacoast. —— Herr Beine has just been sent by the International African association to relieve Becker and replace M. Maluin, whose state of health requires an immediate return to Europe. —— M. J. Lapeyre, second in command of the Giraud expedition, whose health had given way, was obliged to return from Aden to France on that account. — W. H. D. [87

BOTANY.

Systematic histology. — By this term, Vesque designates the systematic classification of plants on the basis of histology. The variations of histological elements, as regards size, shape, and distribution, even in a single genus or species, are very wide, and, with limited exceptions, have not hitherto been regarded as very useful characters in classification. Vesque endeavors to show by an examination of the orders Capparidaceae, Cruciferae, and Frankeniaceae, that some histological characters are so nearly constant as to justify their employment in systematic botany. Such, for instance, are the stomata and hairs, the mucilage-cells, the palisade-cells, the shape and composition of the fibro-vascular bundles, etc. But, as was to be expected, the cases in which the histological characters are uncertain are so numerous as to be discouraging. That the species in many genera can be arranged in natural groups on the basis of their minute structure appears to be pretty clearly made out by Vesque's contributions. — (*Ann. sc. nat.*, Oct., vi. xv. 2.) G. L. G. [88

Flowers of Aesculus glabra. — One of Prof. Coulter's students finds that the perfect flowers of the buckeye are protogynous, while others, which at first sight appear protandrous, really have imperfectly formed pistils. They are thus polygamous, with, it is thought, a tendency to monoicism. Bees, especially Apis, visit them, but go only to unopened buds, from which they obtain nectar by crowding their tongues between the petals. "The open flowers were avoided, and could only have been fertilized by the chance of being near the buds; for the bees had evidently learned that the latter contained the nectar. . . . It is a case of an insect attracted by a flower which it does not visit, but may accidentally fertilize, and obtaining nectar from a flower which it can neither fertilize nor obtain pollen from." The species is worthy of further study. — (*Bot. gazette*, June.) W. T. [89

ZOÖLOGY.

(*General anatomy and physiology.*)

Olfactory lobes of insects and vertebrates. — G. Bellonci, in continuation of his two previous articles (*Mem. accad. sc. Bologna*, 1880, and *Atti accad. reale lincei*, 1880–81) on the olfactory lobes of arthropods, now reports his further observations, which he has also extended to vertebrates. The same fundamental plan determines the structure and relations of the olfactory lobes in both the higher arthropods and the vertebrates. The olfactory and commissural fibres of the lobes are resolved into a fine reticulum, which, grouped in certain spots, forms what Bellonci calls the olfactory glomeruli. The lobes of arthropods have an outer portion with a diffuse reticulum, and an inner portion with glomeruli. In vertebrates the ganglion-cells lie within the region of the glomeruli. In vertebrates and crustaceans there are numerous small, and fewer large, cells. In insects the elements are of small or medium size. In both arthropods and vertebrates the fibres establish both a direct and a cross (chiasma) communication between the olfactory and optic lobes; likewise between the olfactory lobes and the higher centres (reniform bodies of Squilla, fungiform of insects, and hemispheres of vertebrates). These resemblances the author attributes to an analogy of function, and not to a morphological homology between vertebrates and arthropods. The observations were made on Squilla, Gryllotalpa, the eel and frog. — (*Arch. ital. biol.*, iii. 191. A wrong title is given at the head of the pages.) C. S. M. [90

Protozoa.

Action of tannin on Paramecium. — H. J. Waddington states, that, by bringing a drop of a solution of one part tannin in four parts glycerine in contact with a drop containing a Paramecium, the motion of the animal is stopped, and the cilia become beautifully distinct. They appear quite straight and surprisingly long, equal to the short diameter of the body. Previous ideas as to the size and number of the cilia have been very incorrect. To kill infusoria he recommends a saturated alcoholic solution of sulphurous acid; for, if a small quantity be added to water, the gas is set free, and the animals in the water poisoned. He also reports an ingenious device to catch infusoria: crumbs of very hard baked biscuit are put in the water, where they will be held up by confervae; fungoid growths spring from each crumb, the infusoria collect between the filaments as in a favorite resort, and the whole colony may be captured by pulling out the crumb. — (*Journ. roy. micr. soc. Lond.*, iii. 185.) C. S. M. [91

Descriptions of rotifers. — To the eight species previously described of the genus Floscularia, C. T. Hudson now adds three, and gives also some notes on F. regalis Hudson. These four last-mentioned species are described and figured, and a synoptic table of all the species is added. In an appended note, the author comments on Leidy's Acyclus and Dictyophora (cf. SCIENCE, i. 37). He thinks Acyclus is related to the floscules. "Its 'oral cup' with the 'incurved beak' may be fairly said to be the buccal funnel of a floscule reduced to the possession of one lobe, viz., the dorsal one." The remainder is concerned with details, and with the degradation of certain rotifers, considered in connection with the absence of the trochal disk. — (*Journ. roy. micr. soc. Lond.*, iii. 161.) C. S. M. [92

Worms.

Anatomy of Gephyreans. — Dr. C. Ph. Sluiter gives a preliminary notice of his observations on the anatomy of various species. An abstract will be given of his definite memoir when published. — (*Zool. anz.*, vi. 222.) C. S. M. [93

Annelid messmates with a coral. — J. W. Fewkes finds annelid tubes formed on the rim of young Mycedium fragile. As the coral grows, it spreads round the worm-tube; but the latter grows usually equally with coral. The presence of these tubes affects the regular growth of the coral. The species of worm does not appear to have been determined. — (*Amer. nat.*, xvii. 595.) C. S. M. [94

Spermatogenesis of Nemertines. — In an article in the *Revue sc. nat.*, 1882, 165, Sabatier describes the development of the spermatozoa in nemertean worms. The parent cells separate into two parts, the central blastophore and peripheral bodies, which become independent, and attach themselves to the wall of the spermisac. From these bodies the spermatozoa arise by differentiation of the peripheral part into spherules, which elongate and become spermatozoa. In his theoretical conclusion, the author adopts the theory first advanced by Minot (*Biol. centralbl.*, 1882), that the ordinary cells are neuter, or combine both sexual elements, and that when a separation takes place the sexual products are generated. He makes an addition, however, to the theory, by the hypothesis that the central portion is female, the peripheral male. (There are many facts which appear at present irreconcilable with this view of the sexual relations within the cell.) — (*Journ. roy. micr. soc. Lond.*, April, 1883.) C. S. M. [95

VERTEBRATES.

Action of alcohols on the heart. — The relative effects of different alcohols of the marsh-gas series of hydrocarbons upon the ventricle of the frog's heart have been compared experimentally by Ringer and Sainsbury. The method of experimenting was to place the heart in a Roy's tonometer, and feed it with the extract of dried bullock's blood until it was beating normally; the alcohol used was then added to the circulating liquid in such quantities, determined by previous experiments, as to completely arrest the contractions of the heart within an hour. The toxic action of the alcohols used was measured by the dose sufficient to arrest the activity of the heart. The following results were obtained. Normal methyl, ethyl, and propyl alcohol, — all three stop the heart in diastole, the ventricle losing its power to beat spontaneously, and refusing to respond to external stimulation. The excitability of the heart to electrical stimulation is diminished. The 'period of diminished excitability' is shortened. The primary effect of the alcohols on the heart is not, as might be supposed from their therapeutical use as cardiac stimulants, to increase the force or frequency of the ventricular contractions. The height of the curve given by the tonometer diminished steadily from the first application of the alcohol, and the frequency of the beats remained unaffected, except in the later stages, when the power of the heart to beat spontaneously was lost. With regard to the toxic action of the different alcohols, the following numbers are given (the figures represent the number of minims of absolute alcohol in a hundred cubic centimetres of the circulating liquid, necessary to cause complete arrest of the heart): methyl, 205.5; ethyl, 114; propyl (primary), 59.3; isobutyl, 17; isoamyl (amyl alcohol of fermentation), 6.6. The activity of the higher members of the series increases rapidly; and as the propyl, butyl, and amyl alcohols are constituents of fusel oil, we have evidence of the directly injurious effect of this impurity of ordinary alcoholic drinks. — (*Practitioner*, xxx. v. 339.) W. H. H. [96

Pulmonary epithelium. — Bozzoli and Graziadei publish a note chiefly to claim priority for certain of their observations on the lungs. We have only to notice that they have not seen any hyaline plates without nuclei in the epithelium, such as Feurstack has described. They also again insist upon the presence and pathological importance of groups of little cells, not yet differentiated into the special pulmonary epithelial cells (plates). — (*Arch. ital. biol.*, iii. 222.) C. S. M. [97

Birds.

Molecular layer of the retina. — According to Bellonci, the formation of the inner molecular layer of the retina begins in the chick on the eighth day of incubation. At that time there is a special row of clear cells just outside the layer. The cells in the situation of the layer disappear on the ninth day: the clear cells undergo fatty degeneration of the nucleus, and disappear by the twelfth day. They form the molecular layer, which, however, continues to enlarge. Both the inner and outer molecular layer are penetrated by optic nerve-fibres. Thus is produced a structural relation with the molecular layers of the brain. — (*Arch. ital. biol.*, iii. 196.) C. S. M. [98

The birds of Tonkak. — In this paper Herr Müller has given us an elaborate review of the birds of this island, based on a collection of sixteen hundred skins of one hundred and fifty-five species. The paper contains many systematic notes of interest. The author has prepared an extended set of tables from which he concludes that the Tonkak birds belong rather to the Indo-Chinese sub-region than to the Indo-Malayan as given by Wallace. — (*Journ. f. ornith.*, xxx. iv.) J. A. J. [99

Mammals.

Development of the liver and lungs. — In connection with his researches on the development of the body-cavity Uskow made some observations on the liver and lungs of embryos. From the sinus venosus there grow out irregular cavities into the septum transversum, which extend into papillary growths, projecting into the pericardial cavity. The papillae are, of course, covered by a continuation of the epithelium of the pericardial cavity. They afterwards unite into a spongy mesh of tissue, into which the liver extends as it grows. The further history was not followed, but it is probable that the hollow outgrowths from the sinus venosus become hepatic vessels.

Concerning the lungs, from a study of a rabbit embryo of a little less than ten days, Uskow draws the following conclusions. At the time of the closure of the 'vorderdarm,' the separation of oesophagus and trachea is already indicated. The lung is an unpaired evagination of the ventral wall of the 'vorderdarm.' The trachea and the lung arise at the same time, and independently; but the separation of the lung from the 'vorderdarm' precedes the separation of the trachea. The lung arises immediately in front of the liver; at the same time the cells of the mesoderm around the lung proliferate; and Uskow believes that the pleural (i.e., coelom) epithelium forms not only the pleural epithelium, but also the deeper-lying mesodermic elements (muscles, etc.) of the lung. — (*Arch. mikr. anat.*, xxii. 219.) C. S. M. [100

A hybrid between the gayal and zebu. — Dr. Julius Kühn announces the birth, at the agricultural institute of the Halle university, of a hybrid between the gayal of eastern India and the long-horned race of zebus known as sangas, which was held in domestication by the ancient Egyptians, and is now abundant in Soudan and Abyssinia. The hybrid in question is a female; it weighed, at birth, 21.5 kilograms, or about one-twentieth the weight of the sanga mother. The latter is of a mottled red and white color, while the calf is of a clear red brown, only the belly and inner sides of the legs and the fetlocks being white. The hump on the withers, so characteristic of the zebu, is only slightly developed. "In the birth of this animal it is shown that animals of the most primitive forms, which for thousands of years have had unchanged surroundings, by suitable treatment, may remain unimpaired in fertility, even when placed in relations which are in the greatest degree different from those of their native home." — (*Zool. garten*, xxiv. 1883, 126.) F. W. T. [101

ANTHROPOLOGY.

Origin of the Magyars. — Mr. Herman Vambery published a work in Leipzig last year, in which he takes the ground that the Hungarians are of Turkish and not of Finno-Ugrian origin, as is believed by most ethnologists, and especially by M. Hunfalvy. A census of the Turco-Tatar stock is given, which may be of service to some of our readers.

Turco-Siberians	141,992
Eastern Turkestan	1,040,000
Kirghiz	2,299,366
Kara-Kirghiz	350,000
Turcomans	1,000,000
Kara-Kalpaks	70,000
Usbegs	2,500,000
Kipchaks	70,000
Kuramans	77,301
Sarts	900,000
Bushirs	500,000
Tatars	638,710
Nogajs	200,000
Kuvaks [?]	600,000
Kalmuks	71,000
Transcaucasic Turks	900,000
Iranic Turks	200,000
Osmanli	10,000,000
	21,558,369

— (*Archiv. per l'anthrop.*, xii. 297.) J. W. P. [102

Macrobiotia. — The narrative of Genesis about the long lives of the patriarchs has very frequently led to the collation of the ages of persons who have lived to a very great age. Lord Malahide is inclined to give credit to the great number of cases of recorded longevity occurring among the inscriptions recovered from old Roman graves in Algeria and Tunisia. Mr. Renier has published a collection of these, and a still more complete series is by Mr. Willman, under the auspices of the Royal academy of Berlin. Upwards of ten thousand inscriptions are thus calendared.

The following is a list from Numidia: —

101	14 persons.	110	5 persons.
101	10 "	115	4 "
102	2 "	120	3 "
103	1 person.	125	2 "
105	7 persons.	126	1 person.
106	1 person.	127	1 "
107	1 "	131	1 "
108	1 "	132	1 "

At Mastar, a small town, the cemetery yields the following: —

Anna R.	101	Marcela	120
Coecilius	100	Januarius	101
Gargilius	103	Martialis	105
Granius	110	Another	115
Ninava	115	Jussata	105
Petreia	115		

Lord Malahide, in order to show the credibility of these figures, speaks at length upon the duties of the Roman censors. — (*Journ. anthrop. inst.*, xii. 441.) J. W. P. [103

The Pawnees. — Mr. John B. Dunbar of Bloomfield, N.Y., has brought together in a quarto pamphlet his researches into the Pâni family of North American Indians. The tribes embraced in this group are the Pawnees, Arikaras, Caddos, Huecos or Wacos, Keechies, Tawaconies, and Pawnee Picts or Wichitas. The last five are the southern or Red River branches. A brief account of each of these is given in the first few pages of the pamphlet. The third paragraph is devoted to the Arikaras, and the remainder of the monograph to the Pâni, or Pawnees. A very extensive bibliography of the stock has been collected, commencing with the expedition of Lewis and Clarke, and including the publications of Pike, Long, J. T. Irving, Murray, Hayden, and the reports of the several commissioners of Indian affairs. Earlier notices are found in la Harpe, du Pratz, and Charlevoix.

The name 'Pawnee' is probably derived from *Pá-rik-ĭ* (a horn), referring to their peculiar scalp-lock. The original hunting-ground extended from the Niobrara, south to the Arkansas, but no definite boundaries can be fixed.

Mr. Dunbar has collected from various sources the traditions of their origin and migrations (§ 8), their conflicts (§ 9), their census (§ 10), and their later history since the beginning of our century. Considerable space is given to their tribal organization, physical characteristics, social usages, dress, names, lodges, arts, trade, feasts, hunting, war, medicine, mourning, religion, calendar, present condition and prospects. Brief chapters are devoted to the celebrated chiefs, Pitale-sharu, Lone Chief, and Medicine Bull. — J. W. P. [104

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

STATE INSTITUTIONS.

State university of Kansas, Lawrence.

Weather report for June. — The chief meteorological features of this month were the low mean temperature and the abundant rainfall. During the fifteen preceding years, three Junes have been cooler than this, and only one (1876) has had a larger rainfall.

Mean temperature, 71.38°, which is 2.87° below the June average. The highest temperature was 94°, on the 22d and 30th. The mercury reached or exceeded 90° on only six days. The lowest temperature was 48.5°, giving a range of 45.5° for the month. Mean temperature at 7 A.M., 66.22°; at 2 P.M., 80.3°; at 9 P.M., 69.5°.

Rainfall, 7.73 inches, which is 2.80 inches above the June average. There were seven thunder-showers, one of which, on the night of the 11th, continued for six hours, and brought 2.92 inches of rain. The entire rainfall for the six months of 1883 now completed has been 21.80 inches, which is 5.05 inches above the average for the first half-year of the past fifteen years.

Mean cloudiness, 38.56% of the sky, the month being 3.64% clearer than the average. Number of clear days (less than one-third cloudy), 14; half clear (from one to two thirds cloudy), 12; cloudy (more than two-thirds), 4. There were four entirely clear days, and only one entirely cloudy day. Mean at 7 A.M., 42.67%; at 2 P.M., 39.33%; at 9 P.M., 33.67%.

Wind: S.W., 24 times; S.E., 24 times; N.W., 17 times; N.E., 14 times; N., 4 times; S., 4 times; E., 3 times. The entire distance travelled by the wind was 10,737 miles, which is just two miles above the June average. This gives a mean daily velocity of 357.90 miles, and a mean hourly velocity of 14.91 miles. The highest velocity was 45 miles an hour, on the 22d and 23d. The thunder-storm of the 11th was ushered in at 11.30 P.M. by a very strong 'straight' wind, which unroofed a portion of the Central school building at Lawrence, but was in no sense a tornado.

Mean height of barometer, 29.028 inches; at 7 A.M., 29.050 inches; at 2 P.M., 29.013 inches; at 9 P.M., 29.020 inches; maximum, 29.217 inches, on 14th; minimum, 28.671 inches; monthly range, only 0.546 inch.

Relative humidity: mean for month, 74.3; at 7 A.M., 83.1; at 2 P.M., 57.7; at 9 P.M., 82.1; greatest, 97, on 23d and 24th; least, 37, on 14th.

PUBLIC AND PRIVATE INSTITUTIONS.

Ohio Wesleyan university, Delaware, O.

Additions to the museum. — The increase to the collections for the year amounts to 9,202 specimens. The aim of the curator is not to build up a great museum, but one of great educational value, which shall in time contain every specimen needed to explain the facts of natural history as presented in the text-books of the department. All purchases and solicited exchanges are for this end, and even the volunteer exchanges are turned in this direction as far as practicable. W. F. Falconer has given an extensive collection made at the phosphate beds of Charleston, S.C. An elephant's tooth in this collection measures ten by fourteen inches, and weighs twenty-nine pounds.

Prof. R. E. Call of Nebraska, a most enthusiastic naturalist, spent the summer of 1882 on a collecting trip through Georgia. The museum joined with other institutions in defraying his expenses, and sharing the results. Although all the material has not been distributed, over five thousand specimens have been received, and a large number of new and valuable species.

The U. S. fish-commission has presented a collection illustrating the marine fauna of the New England coast. It contains nearly one hundred species, many of which were obtained by dredging at depths as great as two hundred fathoms.

Collections of importance have also been received from the late Mr. C. R. McClellan, a former assistant, and from Revs. J. M. Barker of Mexico, and H. Mansell of India, and the Brothers Willis, recently returned from a tour of the world.

The shelves in all the cases are overcrowded; and at least twenty-five thousand specimens are packed away in boxes and drawers, awaiting study, and room in which to display them. The erection of one or more new cases is required.

NOTES AND NEWS.

The summer courses of instruction in chemistry, offered to teachers by Harvard university, opened July 6, in the chemical laboratories of Boylston hall, and will continue six weeks. The course in general and descriptive chemistry is taken by twelve persons, the course in qualitative analysis by ten, and quantitative analysis by five. There are also eight persons who are engaged on advanced quantitative analysis, organic chemistry, and original research. Lectures are given twice a week on general chemistry, dailv on qualitative analysis, and twice a week on quantitative analysis. The laboratories are open daily from 8 A.M. to 6 P.M. The following states are represented: Maine, Massachusetts, New York, New Jersey, Ohio, Illinois, Michigan, Minnesota, Nebraska, and Georgia. Of the thirty-five persons mentioned above, five are women, and eight are continuing their work from former courses. As in previous years, these courses are under the direction of Dr. C. F. Mabery.

— Upon the death of Charles Darwin, last year, the advocates of evolution in the Paris anthropological society organized a *Conférence annuelle transformiste*, in which one of their number who is a specialist shall set forth the manner in which the doctrine of transformism has affected his department of research, and also the arguments which his studies have furnished for the substantiation of the doctrine. The opening lecture of the course was delivered by M. Mathias Duval, upon the mutual relations of evolution and the embryology of the eye, and is published in the *Revue scientifique* for May 12. The first part of the discussion is an attack upon the doctrine of special creation and final causes. It does not seem to have come to the notice of our French colleagues, that the doctrine of special creation, like all other doctrines (evolution, for instance), has modified itself from time to time by the increase of knowledge. "These admirable appropriations of an organ to an end," says M. Duval, "are explained by the gradual perfecting of a mechanism, which, setting forth from simple and elementary adjustments, develops, by heredity and selection, the forms that are more and more advantageous to the individual. Upon the question whether embryology confirms this theory, it is proposed to examine the successive forms which the eye presents in the animal series, and the successive stages of its development in man or the higher vertebrates. In other words, the phylogeny will first be questioned, and afterward the ontogeny, of the *globe oculaire*, to see whether these two series of facts are a repetition the one of the other." Briefly passing over the unicellular forms, and those in which the eye is undifferentiated, the author commences his more special investigation with the tunicates and amphioxus, from which point the argument is conducted with great precision, and is well illustrated.

— The French academy of sciences proposed as a subject for one of its 1882 prizes the following: "To find the origin of the electricity of the atmosphere, and the causes of the great development of electrical phenomena in storm-clouds." Several memoirs were received by the academy; but no one of them was adjudged worthy of the prize, although a reward and encouragement of a thousand francs was granted to one of the competitors. The academy, therefore, continues the above as one of the prize subjects for 1885. Memoirs will be received up to June 1, 1885. Each must be accompanied by a sealed envelope containing the name and address of the author. The envelope will not be opened unless the memoir is successful. The value of the prize is three thousand francs.

— The sixth annual convention of American librarians will be held in Buffalo, Aug. 14 to 17. The opening address will be delivered by the president, Justin Winsor. Excursions will be made down the Niagara River, and, at the close of the session, to Niagara Falls. Further details may be obtained from Mr. John N. Larned, Young men's library, Buffalo.

— The Smithsonian institution will soon publish

Professor Bolton's Catalogue of scientific and technical periodicals. Proof-sheets have been sent to the leading libraries of the country, with the request that it should be noted what journals might be on their shelves; so that we shall have a complete list of available scientific periodicals.

— The Johns Hopkins university circular for June is given up to a statement of the work of the past year, and a programme of the courses offered for the year 1883-84.

— According to *Nature*, the emperor of Austria, on June 5, inaugurated the new Vienna observatory on the Turken Schanze, in the northern outskirts of the town. The new building has taken nine years to construct; and during that time the present director has travelled all over Europe and America in order to study the construction and equipment of the best observatories. The result is, that the Vienna observatory is probably one of the most complete in existence.

— Dr. Ph. Paulitschke's work on the '*Geographische erforschung des afrikanischen continents*' (Vienna, 1880), in which he gave a brief statement of the work of all explorers from ancient times down to the date of publication, is now supplemented by his '*Afrika-literatur in der zeit von 1500 bis 1750 n. Chr.*' (Vienna, 1882), — a work of 122 pages, with 1,212 titles. Valuable cartographic aid to study in the same direction is given in H. Kiepert's maps of the progress of African exploration from 1750 to 1873, and of the expeditions of this century, colored according to their nationality; these being published in the journal of the Berlin geographical society in 1873 and 1874, and again in the ten larger scale charts of inner Africa by Petermann and Hassenstein, issued as a supplement to the *Mittheilungen* in 1863.

— Mr. W. G. Black is preparing the index for his Folk-medicine, already in print, and to be issued immediately by the Folk-lore society. The work treats of the origin and communication of disease, and the influence in folk-medicine of charms, saints, and heavenly bodies.

The same society hopes soon to obtain for publication a collection of Zulu nursery literature, which has been in the hands of Bishop Callaway for ten years. This will be an addition to folk-lore of very great interest and value.

RECENT BOOKS AND PAMPHLETS.

Adrian, T. Ueber projectivitäts- und dualitäts-beziehungen im gebiete mehrfach unendlicher kegelschnittschaaren. Berlin, 1882. 54 p. 8°.

Ambühl, G. Anleitung zur milchprüfung. St. Gallen, *Huber*, 1883. 43 p. 8°.

Amunátegui, M. L. El terremoto del 13 mayo de 1647. Santiago de Chile, 1883. 620 p. 4°.

Ballard, H. H. Hand-book of the St. Nicholas Agassiz association. Pittsfield, *Axtell & Pomeroy, pr.*, 1882. 5+85 p. 24°.

Barron, A. F. Vines and vine-culture: being a treatise on the cultivation of the grape-vine, with description of the principal varieties. London, 1883. 240 p., illustr. 8°.

Bastian, A. Volkerstämme am Brahmaputra und verwandtschaftliche nachbarn. Berlin, *Dümmlers*, 1883. 70+130 p., 2 col. pl. 8°.

Béchamps. Les microzymas dans leurs rapports avec l'hétérogénie, l'histogénie, la physiologie et la pathologie. Paris, 1883. 8°.

Behrend, G. Eis- und kälteerzeugungs maschinen, nebst einer anzahl ausgeführter anlagen zur erzeugung von eis, abkühlung von flüssigkeiten und räumen. Halle, 1883. 8°.

Bersch, J. Die verwerthung des holzes auf chemischem wege. Die fabrikation von oxalsäure, alkohol und cellulose, der gerbstoff- und farbstoff-extracte aus rinden und hölzern, der ätherischen oele und harze. Wien, 1883. 368 p., illustr. 8°.

Bleunard, A. Le mouvement et la matière. Lectures sur la physique et la chimie. Paris, 1883. 374 p., illustr. 8°.

Branco, W., und Reiss, W. Ueber eine fossile säugethierfauna von Punin bei Riobamba in Ecuador. Mit geologischer einleitung. Berlin, 1883. 166 p. gr. 4°.

Brown, J. E. The forest flora of South Australia. part I. London, 1883. pl. f°.

Buccola, G. La legge del tempo nei fenomeni del pensiero; saggio di psicologia sperimentale. Milano, *Dumolard*, 1883. *Bibl. intern.* 15+432 p. 8°.

Buckland, F. Log-book of a fisherman and zoölogist. New edit. London, 1883. 352 p., illustr. 8°.

Candolle, A. de. L'origine delle piante coltivate. Milano, 1883. 644 p. 8°.

Cantor, G. Grundlagen einer allgemeinen mannigfaltigkeitslehre, mathematisch-philosophischer versuch in der lehre des unendlichen. Leipzig, *Teubner*, 1883. 61 p. 8°.

Cerón, S. Estudio sobre los materiales y efectos usados en la marina. Cádiz, 1883. 652 p., illustr. 4°.

Congresso geografico internazionale terzo tenuto a Venezia dal 15 al 22 settembre, 1881. vol. i. Notizie e rendiconti. Roma, *Soc. geogr. ital.*, 1882. 404 p., pl. 8°.

Cotteau, Peron, et Gauthier. Échinides fossiles de l'Algérie. fasc. i. Terrains jurassiques. Paris, 1883. 79 p., illustr. 8°.

Credner, H. Geologische profile durch den boden der stadt Leipzig und deren nächster umgebung. Leipzig, *Hinrichs*, 1883. 5+71 p., pl. f°.

Dawidowsky, F. Fabrication of glue, gelatine, cements, pastes, mucilages, etc. Translated from the German, with additions, by W. T. Braunt. Philadelphia, 1883. 275 p. 12°.

Dodel-Port, A. Illustrirtes pflanzenleben. Gemeinverständliche originalabhandlungen über die interessantesten und wichtigsten fragen der pflanzenkunde. Zürich, 1883. 490 p., illustr. 8°.

Faà di Bruno, F. Théorie des formes binaires. Turin, 1883. illustr. 8°.

Faber, G. L. The fisheries of the Adriatic and the fish thereof, with a systematic list of the Adriatic fauna. Preceded by an introduction by Günther. London, 1883. illustr. 4°.

Falkenburg, C Neue schieberdiagramme und neue theorie der dampfvertheilung in anwendung auf die steuerung der stationären und locomotorischen dampfmaschinen. Leipzig, 1883. 8°.

Faramelli, T. Descrizione geologica della provincia di Pavia, con annessa carta geologica a calori nella scala di 1 per 200,000. Milano, 1882. 104 p. 4°.

Graetz, L. Die elektricität und ihre anwendungen zur beleuchtung, kraftübertragung, metallurgie, telephonie, und telegraphie. Stuttgart, 1883. illustr. 8°.

Gross, V. Les Protohelvètes ou les premiers colons sur les bords des lacs de Bienne et Neuchâtel. Avec préface de Virchow. Berlin, 1883. 120 p., illustr. 4°.

Halphen. Mémoire sur la réduction des équations différentielles linéaires aux formes intégrales. Paris, 1883. 301 p. 4°.

Harting, J. E. Sketches of bird life from 20 years' observations of their haunts and habits. London, 1883. 302 p., illustr. 8°.

Heen, M. P. de. De la dilatabilité de quelques liquides organiques et des solutions salines. Bruxelles, 1883. 51 p., illustr. 8°.

Helderich, T. de. Flore de l'île de Céphalonie ou catalogue des plantes, qui croissent naturellement et se cultivent le plus fréquemment dans cette île. Lausanne, *Beidel*, 1883. 90 p. 8°.

Hellriegl, H. Beiträge zu den naturwissenschaftlichen grundlagen des Ackerbaues. Braunschweig, 1883. 8°.

Herbert, D., *edit.* Selection from the prize essays of the International fisheries exhibition, Edinburgh, 1882. New York, 1883. illustr. 8°.

Hofmann, E. Der käfersammler. Stuttgart, 1883. illustr. 8°.

SCIENCE.

FRIDAY, JULY 27, 1883.

THE ADVANTAGES OF STUDY AT THE NAPLES ZOÖLOGICAL STATION.

THE opening of the marine laboratory in Naples in 1874 marks an important epoch in the progress of biological studies, as seen, not only in the prodigious and ever-increasing amount of work which it produces, but also in the general interest which its success has inspired in other quarters. As in America sea-side schools and laboratories may be traced to the example set at Penikese, so in Europe most of the marine laboratories owe their origin to influences emanating from Naples. But the beneficial influence of the Naples station is by no means confined to Europe. Already we hear of marine stations in Algiers, in Sydney, and in Java. In Japan too, as we are informed, a laboratory has been established by Professor Mitsukuri in a Buddhist temple, — an example the moral of which is easily drawn. Thus the prediction made by the founder of the Naples station, Professor Anton Dohrn, some ten years ago, — that marine zoölogy was destined to become paramount, and that the earth would soon be encircled by a net-work of zoölogical stations, — seems to be rapidly approaching its fulfilment.

Every one can now see that the Naples laboratory was a gigantic enterprise, magnificent alike in conception and in achievement, although few are aware of the magnitude and varied nature of the difficulties which opposed its progress. It is a matter for rejoicing, that this institution was planned on such broad and liberal views, and with such wise prevision of the course its development should take in order to secure a long and prosperous existence. With the addition of a physiological department now determined upon, it becomes a biological station in the broader sense of the word, — an organization on a grand scale for the study of marine life in all its aspects. Its brilliant career during the first nine years of its existence not only insures its permanency, but also gives pledge of future growth commensurate with the ever-expanding needs of biological research.

The station is no less liberal in its management than comprehensive in its aims; for it opens its doors to naturalists from all quarters of the globe on like conditions. It is the international character of the station, combined with the natural advantages of situation, which has made it, in so short time, the Mecca of biologists, and a seat of unprecedented prolific activity. The mild and equable climate of Naples, the unsurpassed richness of the fauna and flora of its bay, and the best equipped laboratory in the world, conspire to give the Naples station pre-eminence among institutions of its kind, and to render it probable that it will remain what it is now acknowledged to be, — the world's great biological station.

The detailed account given in Miss Nunn's valuable article (Science, Nos. 17 and 18) makes it unnecessary to enter here into a description of the laboratory; and Mr. Cunningham's excellent review of the work which it has already accomplished (*Nature*, March 15) is doubtless accessible to most of the readers of Science.

Let us rather consider the practical question of our own interest, as Americans, in this institution. Except in a single and noteworthy case of very recent date, we have thus far taken no active interest in this matter. The distance between us and Naples has seemed to foster the idea that we have no immediate and common concern with European nations in opportunities that lie so much nearer their doors than ours. But recent events have demonstrated that there *is* a demand on the part of American naturalists for just such opportunities as are now offered at Naples, and nowhere else; and with them political isolation is not likely to be mistaken for scientific isolation. That this demand does not arise from whimsical reasons will certainly be conceded by all who understand its meaning. Still there may be some who will ask if the field for investigation is not sufficiently broad at home, and the facilities for work sufficiently ample, to satisfy the requirements of American naturalists. With all due respect to such queries, we would suggest that they do not contain the gist of the matter: for even on the preposterous supposition that our facilities for biological research are fully as great as those at Naples, no one could claim that they are identical; so that it would still be pertinent to ask, Can we not profitably *add* the advantages in Naples to those enjoyed at home? The real question comes to this: Are there advantages at Naples which are not offered here, and are they worth the time and money required to obtain them? Now, it is no disparagement to home talent and resources, to say that the advantages of study at the Naples station are incomparably greater, and certainly more numerous, than those at our command. More than this, there is not a single laboratory in Europe where the student of natural history can pursue his studies under so favorable circumstances as at Naples. This is doubtless much to say, when we remember that the laboratories of Huxley, Lankester, Lacaze-Duthiers, Van Beneden, Leuckart, Haeckel, Gegenbaur, Claus, Semper, Kölliker, Barrois, and Giard are of world-wide repute; but it is not merely our private opinion, it is an acknowledged fact. Of course, we are not now speaking of the comparative merits of this institution for students just beginning their studies, but for those who are already more or less prepared for independent work.

The Naples station makes no pretension to fulfilling the functions of a school or a college: its aim is to advance biological research; and to this end it consecrates all its energies. It is a laboratory organized and equipped, not for training the inexperienced, but for aiding the investigator. It represents, in many respects, the excellences of all the best laboratories of Europe combined, and surpasses them all in the inexhaustible wealth of its resources, and in the many exceptional advantages that naturally spring from its international character.

Although no lectures or courses of instruction are provided for, an able staff of assistants are constantly employed, whose aid and counsel in all matters pertaining to methods of work leave nothing to be desired. It is one of the great advantages of work at the station, that it gives one opportunities for the acquisition of methods. An institution which pushes research with such energy and success will naturally be prolific in the discovery of ways and means. The station brings together a body of zealous workers from the best laboratories of Europe, and thus, besides giving a rare opportunity for the formation of valuable acquaintances, direct interchange of thought, and discussion of problems, opens another way for the accumulation and refinement of methods. It is in this way that it becomes a sort of international depot for the reception of discoveries and improvements made elsewhere. The heterogeneous material thus obtained is sifted, systematized, tested, further elaborated and refined, and redistributed. The methods of microscopical research published by Paul Mayer, and the well-known discoveries of Giesbrecht, show that the station is doing no less important work as an originator than as an accumulator and a distributer of methods.

Now, whoever knows the value of methods — and we need not argue with those who do not — will admit, that, in this particular, the Naples station is unrivalled, and that, from the nature of things, it will probably remain so indefinitely. However successful we may become in the development and application of methods, we are not likely to see the time when it will not be desirable to see, and to know by experience, how work is done at Naples. This one but all-important matter, to say nothing of the many other advantages that must accrue to an occupant of a table at the station, — such as social intercourse, direct knowledge of a very important fauna, and opportunities of acquiring a knowledge of the four languages with which every naturalist must now be familiar, — makes it very desirable, particularly for our younger naturalists, to spend some time at Naples.

One of the indispensable requisites to successful work in natural history is an extensive library; and this is precisely one of the needs most felt in seaside laboratories. As a rule, naturalists are compelled to select a few of the books which they conjecture will be useful to them, and transport them to the place of study. This method is, of course, very unsatisfactory, for reasons too obvious to be mentioned. The Naples station has met this difficulty by establishing a permanent library in an apartment adjoining its laboratory. Already this library has become one of the most complete biological libraries in Europe, and forms one of the chief attractions of the station. Its management, we are happy to say, is the least conspicuous thing about it. Those accustomed to depend upon public libraries, open only at stated hours, approached only through officials, and encumbered with rules, blanks, fines, etc., have a pleasing sense of relief on finding the doors of this rich library thrown open to them, with the liberty of helping themselves at any time to whatever books are desired, with no further requirement than to place a card bearing their name in the place of each book taken. This simple device enables others who chance to want the same books to know precisely where to find them.

The supply of material furnishes another topic well worth consideration in this connection. It is the method of supply, rather than its richness, which merits attention. An organized body of men is constantly employed for this purpose; and they make it their business not only to know what material can be obtained, but also when and where. These men now work with all the advantages of long experience and systematic training. The occupant of a table has only to announce what object he wishes to study, and it is delivered alive at his table. In this way the investigator is able to accomplish the largest amount of work in a given time, and with the least possible annoyance.

The furnishing of the table also deserves attention. Within twenty-four hours after notice is given, one finds his table ready for use, supplied with drawing-material, a large variety of reagents, staining-fluids, and all the appurtenances required for the most difficult kinds of research. It is not the raw material that one finds on his table, but every thing actually prepared and ready for immediate use. Further needs are promptly supplied on request. Thus every thing is arranged to save the time of the investigator, and render his work as effective as possible. Compare these facilities for study with those offered anywhere else, and the contrast is at once apparent.

The conservator's department, under the direction of Salvatore Lo Bianco, has become one of unusual interest and importance; and the work it is doing deserves to be generally known in this country. The work of this department is the preservation of all the material brought to the station, except what is required to supply the tables and the public aquarium. The success with which this most difficult business of preserving marine animals in lifelike appearance is accomplished, is certainly marvellous, and richly deserves the highest tribute of praise. This department is producing results of immense value to science, and its usefulness is now widely recognized. Its beautiful preparations adorn the shelves of nearly every museum in Europe; and it is constantly sending out supplies to laboratories for teaching purposes. Many naturalists who find it inconvenient to work at Naples are supplied by this department with material in such perfect state of preservation for anatomical and histological study, that they are enabled to carry out their investigations without once visiting the station. There are undoubtedly museums and laboratories in this country that would do well to avail themselves of this opportunity. This department has been created for the special purpose of serving science in the above-named ways, and not for increasing the funds of the station; and hence the preparations are made for a sum that scarcely more than covers the expense of the alcohol and other reagents used in their preservation.

There is still another way in which this department of the station might be of importance to this country. Doubtless some arrangements might be made between our naval authorities and the director of the station, such as have been made in the case of Germany and Italy, which would enable us to send an officer from time to time to the station, with a view to gaining a practical knowledge of the methods of preserving animals. In this way each of our war-ships might be supplied with one officer prepared to take advantage of the rare opportunities for advancing our knowledge of marine life which arise in the course of their distant cruises.

In view of the considerable number of American students in the biological laboratories of Europe, and the many applications on their part for permission to work at Naples, there has naturally been some surprise at the fact that America has hitherto declined to contribute any thing towards the support of the station. The honor of taking the first step towards rectifying our mistake in this matter belongs to Williams college. It is to be hoped that the example set by President Carter and the trustees of this college will not long remain the only evidence of our appreciation of the Naples station. Three or four tables will at least be required to meet the demands of our zoölogists alone, judging from the number now at work there. It is not right that American students should go to Naples as beggars, to be received out of courtesy, or indirectly through the liberality of English or German universities. Of the twenty-six tables now taken at the station, Germany controls twelve; Italy, four; England, two; Russia, two; Belgium, two; Holland, one; Hungary, one; Switzerland, one; and Williams college, one. There are four tables not yet disposed of, two of which, at least, should be secured at once by America. Will not some one or more of our universities take this matter in hand?

The establishment of a biological station at Wood's Holl, which, in the hands of Professor Baird, will doubtless be pushed to a speedy completion, will create facilities for the study of marine life on a much larger scale than we have hitherto seen in this country; and the successful issue of this enterprise, we venture to predict, will increase rather than diminish the number of American naturalists at Naples. Whatever improves our facilities for study will tend to increase the general interest in biology, and to augment the number of naturalists who will seek the best that the world affords in the way of methods. The time will never come when direct interchange of thought, and comparison of methods of research, will cease to be of the highest importance to the biologist. On the contrary, these things will become more and more a necessary part of the experience of every one who aims to be a useful and successful student of life. The progress of biological studies will soon create a demand for more than one international laboratory, and we certainly hope that the new station at Wood's Holl will take this character. The establishment of several great stations at different points, selected according to the relative richness and importance of the fauna and flora, each offering facilities for study similar to those enjoyed at Naples, and open to naturalists of every country, would prepare the way for a concentration and organization of forces, and inevitably raise the standard of work, and check the accumulation of driftwood. It is obvious that the usefulness of one station would not be impaired by the existence of others, since the work of each would be supplementary to that of the others.

The character and importance of the publications of the station have been so well stated by Mr. Cunningham in the article before referred to, that little remains to be said on this topic. In looking over the list of subscribers to the *Fauna and flora*, we are again forced to acknowledge the slender interest which America has taken in the Naples station. Here is a colossal series of magnificent monographs, designed to give an exhaustive treatment of the plants and animals found in the Gulf of Naples, and published at a price that ought to insure them a place in the private library of every zoölogist and botanist in the country; and yet the list of subscribers, according to the last circular, numbers only eight. Even such countries as Holland and Switzerland outdo us. Austria and Russia have each twice this number of subscribers; Italy has nearly four times, England about five times, and Germany ten times, as many.

As our poor representation cannot be attributed wholly to indifference, it is safe to conclude that these monographs are not so generally known as they deserve to be. Thirty of the series have already been announced, six of which have been completed. From two to four are published each year in quarto form, and illustrated with numerous expensive plates, at an annual subscription-price of only twelve dollars and a half. The number of subscribers is now two hundred and seventy, and the three hundred and fifty copies of Dr. Chun's *Monographie der Ctenophorae* — the first in the series — have been already nearly exhausted. The monographs are written either in English, German, French, or Italian, according to the preference of the authors. Such brilliant achievements in the line of exhaustive research as are embodied in these monographs certainly command our homage, and assuredly deserve a more generous recognition than they have yet received in this country.

C. O. WHITMAN.

THE NATIONAL RAILWAY EXPOSITION.[1] — III.

IN England and Europe generally, signals of every conceivable variety have been used; but experience has shown that the semaphore is the best signal, and its universal adoption in Great Britain and on the busiest railways on the continent of Europe is a good example of the doctrine of the survival of the fittest. The exposition, we regret to observe, contains many forms of signals that are neither distinct in appearance nor positive in meaning. It is hard to say whether some of them mean safety or danger. A mere change

[1] Continued from No. 23.

of color from red to white, without any change of form, conveys no information whatever in certain states of the weather and with certain backgrounds. Other signals are alike, back and front. Facing the train, they signify danger; standing edgewise, they mean safety: but unfortunately it is difficult to know whether they refer to an east-bound train or a west-bound train; and, though they may be placed on the right hand of the engineer to whom they refer, this arrangement is not always free from ambiguity.

The semaphore signals, as shown at the exposition, consist of vertical posts which have one or more arms pivoted at their upper ends; and these arms are capable of moving through a right angle in a vertical plane. An arm raised to a horizontal position signifies danger; inclined at an angle of about 45°, it signifies safety. A powerful lamp is fixed near the top of the post; and, when the arm stands horizontally, a disk of red glass stands in front of the lens of the lantern, which then, of course, shows a red light, indicating danger. When the arm drops to an angle of 45°, the red disk moves, and leaves the lantern unobscured, showing a white light, and indicating safety.

The semaphore arms are weighted, so that their normal position is horizontal, indicating danger; and the signalman has to overcome this weight in pulling them to safety. The object of this arrangement is, that the breakage of the connection between the lever in the signalman's cabin and the semaphore will release the signal, and let it fly to danger.

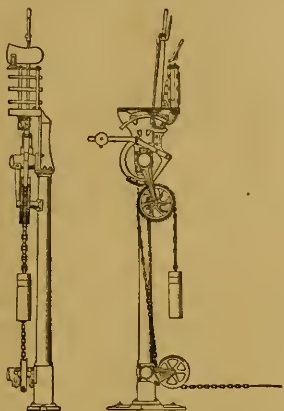
It is usual to place one signal at or as near as possible to both the signalman's cabin and the spot where the engine of an advancing train should stop if the signal is against the train. This signal is called the 'home' or 'main' signal. Another signal is placed some distance off in the direction from which the train comes: this is termed the 'distant' signal. The object of this arrangement is, that, on catching sight of the distant signal, the engineer is warned, and has some time and distance in which to stop his train before he reaches the home signal, beyond which the danger lies.

As the levers work switches and signals at a considerable distance, the connections between them have to be carefully made and protected from accidental injury and the effects of the weather, while the difference in length due to difference in temperature has to be compensated for; so that the signal is moved with certainty, though the wire or pipe connecting it to the lever vary in length several inches in the twenty-four hours, owing to the difference in temperature between the day and night. The Pennsylvania steel company exhibits an especially neat device for keeping the wire or connection to a distant signal always tight. The wire is kept stretched by an ingenious application of the pull of a weight, which acts only when the signal is in its normal position of danger to which it is weighted. When the signal is

SEMAPHORE.

pulled to safety, it is directly controlled by the signalman.

Connections to switches are generally made by means of rods or pipes jointed together,



DEVICE FOR KEEPING SIGNAL-WIRE TIGHT.

and running on rollers. A 'trunking' or wooden covering is then placed over them to protect them from snow and the feet of any-one walking about the yard.

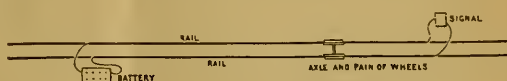
As it is very important that the movement of switches should be absolute and exact under all conditions, — that is to say, that the switch be always either tightly closed or wide open, and never stand partly open, — a compensating arrangement is introduced half way between the switch and the signal, so that, whatever the variation of length of connection from temperature, the switch is unaffected, and its movements can always be under exact control.

COMPENSATING JOINT FOR EXPANSION OF RODS.

The full lines show the position in cold weather; the dotted lines, in hot. It is evident, however much the rod expand, the distance between switch and signalman is unaltered, and therefore the movements of the switch and lever are unaffected.

In working railroads, some difficulty has always been experienced in keeping trains running in the same direction, on the same line of rails, from running into one another, as naturally, on a crowded line, an accidental stoppage to even a fast train may enable a slow train to overtake it and cause a rear collision. The Pennsylvania railroad adopted, some years ago, what is known as the block system, by which a definite interval of space (the distance between two adjoining signal-cabins) can always be maintained between two following trains. The system is too well known to need description here; but Mr. George Westinghouse has invented a system in which the same results are obtained, not by men signalling from one cabin to another, but by the trains themselves operating signals through the medium of electricity. The principle of the invention is easily understood, although the details are complicated and the results marvellous. A battery is connected to each signal by means of the rails, the current flowing to the signal by one rail, and returning by the other. The presence of an axle and pair of wheels on the track enables the current to flow through them, instead of through the signal apparatus. Directly the current is thus short circuited, the signal flies to danger.

This simple principle is so ingeniously worked out in detail, that a train approaching a road-crossing rings a bell fixed on a post at the crossing until the crossing is reached, when the bell stops ringing; and this is done by trains travelling in either direction. In working on an ordinary piece of road, two signals behind the train are always kept at danger; and, on a single line, two signals in advance of the train are always kept at danger against a train advancing in the opposite direction. In a few words, the trains warn one another of their proximity.



AUTOMATIC ELECTRIC BLOCK SYSTEM.

We have dwelt on the subject of signals at considerable length, as the question is novel, and of great and growing importance; and we have no doubt that those who take an interest in railroads have found much to be gained by visiting the exposition, and studying this question on the spot. The two exhibits we have mentioned represent the best results attained in England after forty years' patient and careful study of signals, under such trying conditions that the very existence of railways there depends upon the handling of enormously concentrated traffic with safety, certainty, and rapidity; and the results of these labors are probably not far from a perfect solution of the problem, and deserve our most careful study.

(To be continued.)

FIFTEENTH ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.[1] — II.

ON Thursday the convention again assembled at St. Paul, at 11 A.M., and listened to a paper by J. P. Frizzell of St. Louis, upon the water-power at St. Anthony's Falls. The height of fall, watershed, rainfall, and horse-power utilized were given. He criticised the means taken for preserving the falls, the building of storage-dams at the head waters of the Mississippi, and the method of using the water at Minneapolis. He condemned the waste of power occasioned by a gross disregard of the laws of hydraulics, and pointed out the remedy. He stated that three things should be done, — the U. S. government must be induced to withdraw wholly, leaving the work of preservation of the falls to the owners of water-power; the two companies controlling the power must be united under one management; the natural width of channels at the falls must be restored.

Capt. O. E. Michaelis, U.S.A., followed with a short paper on metrological investigations, which he said were brought about by the attempt to determine how much a certain bullet was 'out of true.' He constructed, and exhibited an instrument closely allied to the spherometer, to which he gave the name of 'tripod caliper.' He read results of measurements with this instrument, and applied it further to testing the accuracy of one turn of a screw-thread.

Mr. D. J. Whittemore, chief engineer of the Chicago, Milwaukee, and St. Paul railway, read a brief paper on the use of the Nasmyth steam-hammer for driving piles, and gave instances of the hindrance which a very slight 'brooming' of the pile-head offered to the effective action of the hammer. He also submitted a section from the top of a green Norway pine pile, where the friction of the fibres, under the rapid blows of the hammer, had generated sufficient heat to burn the heart of the head of the pile quite across.

Papers by Benjamin Reece, of Toledo, O., upon railway-track repairs, and by J. W. Putnam, upon cause of decay in timber, were read by title, and ordered printed in the proceedings.

[1] Concluded from No. 24.

In another room, before the persons most directly interested, a paper was read by F. P. Stearns of Boston, upon the current meter, giving a theory for the maximum velocity of water, flowing in an open channel, being found below the surface.

The society then held a business-meeting, in which a committee for nominating officers of the society was elected. Committees on uniform tests of cement and on the preservation of timber were granted further time. The committee appointed to procure aid from Congress to carry on the tests of iron and steel reported progress, and was continued.

The special committee on standard time made a report through Dr. Eggleston to the effect that they had obtained a general expression of opinion from men prominent as engineers, railway managers and operators, and others in all parts of the United States and Canada, and found that exceptional unanimity prevailed with respect to the fundamental principle which should govern in the adoption of a system of standard time for the whole country. The benefits of a change from the present lack of system were illustrated, and it was claimed that the time had arrived for action in the matter. The report was accepted, and the committee continued.

The convention at St. Paul then adjourned. The U. S. engineer officers on duty in this vicinity had an exhibit, in another room, of plans showing the various works of improvement under their charge.

On Friday, June 22, the convention met in Minneapolis. The party was carried from Hotel Lafayette across Lake Minnetonka by steamer, and thence by a narrow-gauge railway, in open cars, to the city. The meeting took place in the opera-house. A welcome was given by ex-Mayor Rand in behalf of the city; a reply and the annual address, in the absence of President Charles Paine, was read by Director William Metcalf, who took for his subject 'Engineering improvements in the Mississippi valley.'

Mr. William P. Shinn then read a paper upon the subject, 'How can railways be made more efficient in the transportation of freight?' which is a sequel to his paper of similar title read at the annual meeting in 1882, and aims to sum up the discussion, and more particularly to reply to the criticisms of Mr. O. Chanute thereon. He claims that facts and figures, which he adduces, prove that the present mileage basis for the adjustment of car accounts between different railroad companies is unjust to the companies furnishing the cars; that it is costly and discouraging to prompt shippers; that it leads to slow movement of loaded cars and to non-movement of empty cars; that it is not practised in other countries, nor does any like practice obtain in any other business in this country. The *per-diem* basis, on the contrary, is perfectly practicable, as proved by two years' trial on the Union Pacific, and Chicago, Burlington, and Quincy railroads, and its use in a modified form in two European countries.

At noon the convention adjourned. The rest of the day, and Saturday, were given up to the very pleasant excursions and entertainments furnished by the people of the vicinity.

If one-half as much is done to render the coming meeting of the American association pleasant, those who attend will find themselves well entertained.

SOME GEYSER COMPARISONS.

HAYDEN'S twelfth annual report, published by the U. S. interior department, has been in the printer's hands for some time, and will doubtless be shortly issued from the government printing-office. Part ii. of this report relates to the Yellowstone national park, and in it the hot-springs are fully described, and the geology and topography of the park treated of in detail.

It is proposed here to point out briefly some of the differences in relation to geysers between the results of the work in the park and those reached by Bunsen in his study of the Iceland field. It is not necessary to present Bunsen's conclusions in detail, nor to describe his theory, with which doubtless the majority of the readers of SCIENCE are familiar.

Bunsen's conclusions, as presented here, are mainly the same as stated by LeConte in his Elements of geology, although not considered in the same order.

1. Bunsen found in Iceland two kinds of springs, viz., *acid springs* and *alkaline carbonate springs;* and he says that only *alkaline carbonate springs* become siliceous, and that only silicated springs form geysers.

2. The silica in solution does not deposit on cooling, but only by drying.

Our observations in the Yellowstone national park in the main verify this last conclusion, and it is inserted, because LeConte takes exception to it as follows: "This, however, is not true; for the Yellowstone geyser-waters, which[1] deposit abundantly by *cooling*, evidently because they contain much more silica than those of Iceland."

[1] This is evidently a grammatical error.

The following table gives the results of the observations in the park as far as they have been made in regard to the points just enumerated.

Name.	Character of spring.	Grains of silica to imperial gallon.	Reaction of water.	Condition of water after three years, when bottles were opened.
Jug . .	Quiet spr'g,	14.56	Alkaline,	Perfectly clear, no deposit.
Echinus .	Geyser . .	10 60	Acid . .	Perfectly clear, no deposit.
Pearl . .	Geyser . .	7.84	Alkaline,	Clear, with small deposit of gelatinous silica.
Opal . .	Quiet spr'g,	53.76	Alkaline,	Opaline as when bottled, no deposit in bottle.

Here, then, we have an alkaline spring and an acid spring, both of which are geysers. We see, also, that the mere fact of cooling has little to do with the throwing down of the silica, nor does the precipitation appear to be due to the amount of silica held in the water. Ordinarily the formation of siliceous sinter or geyserite must be explained by the evaporation or drying of the water as it flows from the springs, or falls from the geysers.

The chimney-like form is very noticeable in the craters of the Yellowstone geysers; and LeConte attributes it to the greater abundance of silica in solution in the waters of the Yellowstone geysers.[1]

As a fact, however, the analyses already made of geyser-waters from the park show usually a smaller percentage of silica than do those of Iceland. Opal spring (see table above) is an exception, and it is a spring without the least appearance of a crater or chimney. The real explanation is probably in the greater age of our geyser region.

3. Bunsen's conclusions as to temperature are as follows: —

a. The temperature increases with the depth of the tube.

b. At no point in the tube does the water have the temperature of ebullition which it should have under the pressure to which it is subjected.

c. The temperature depends on the time that has elapsed since the last eruption; and, as a great eruption approaches, the nearer it comes to the boiling-point.

d. At a depth of forty-five feet in the Great geyser, the difference between the observed temperature and the calculated boiling-point of the water for that depth and pressure was the least.

[1] Elements of geology, p. 104.

In the Yellowstone national park, wherever deep temperatures were taken in active springs and geysers, they were found to increase with the depth; but temperatures of ebullition were found at the surface of many springs, and in some the temperatures exceeded the boiling-point. As the time for an eruption in a geyser approached, the temperature increased, which fact agrees with Bunsen's observations.

In 1865 a Mr. Bryson of Edinburgh found that the tube of the Great geyser of Iceland has a ledge about forty-five feet below the top of the tube, and that, from beneath this ledge, steam-bubbles rose while the tube was filling. A thermometer sunk to this point was violently dashed about and broken, but, when sunk below it, was quiet and undisturbed. The conclusion is, that here is an opening by which steam and superheated water have access to the main geyser-tube from the side. Similar side-openings are known to exist in Strokhr; but the Great geyser is so full of water that its structure cannot be so readily studied as in the case of the smaller Strokhr. In Bunsen's theory this point forty-five feet below the surface plays an important part. He allowed his thermometer to remain at the bottom of the geyser-tube during a great eruption, and it was undisturbed. Mr. Bryson's discovery explains its safety. It was below the active side-vent of the geyser.

Bunsen's conclusion would therefore probably have to be modified so far as relates to the temperature of ebullition not being reached; for, could he have obtained temperatures in the side-conduit, there is but little doubt that the boiling-point would soon have been reached, even for the pressure of that depth. The mass of water in the main tubes prevents that condition at the surface; and, when it is attained opposite the aperture, an eruption occurs.

Bunsen's theory of the formation of geyser-tubes also requires some modification. Contrary to his opinion, the deposit of silica is not necessary for geyseric action. In the Gibbon geyser basin in the national park are several geysers conspicuous from the small amount of siliceous deposit surrounding them; and one in 1878 was entirely without a deposit, having just broken out as a steam-vent. By the following year it had settled down to regular geyser action.

As already mentioned, there are, in the park, geysers the water of which is acid in reaction; and therefore the theory that before developing into a geyser the spring must pass through a preliminary tranquil or non-eruptive stage (in which it is an acid spring) is not warranted by the facts observed in the Yellowstone region. It is probable that all geysers are originally due to a violent outbreak of steam and water, and that the first stage is that of a huge steam-vent. Under such conditions, irregular cavities and passages are more likely to be formed than regular tubes. The lining of the passages and tubes takes place afterwards, and is a slow process. Whether the subterranean passages in which the water is heated are narrow channels, enlargements of tubes, or caverns and tubes, is probably of little consequence, except as the periods or intervals of the geyser are influenced. If water in a glass tube be heated rapidly from the bottom, it will be violently expelled from the tube, or, if boiled in a kettle that has a lid and a spout, either the lid will be blown off, or the water will be forced out of the spout. In the first case we have an explanation, in part at least, of Bunsen's theory; and the second exemplifies the theories which presuppose the existence of subterranean cavities and connected tubes. The simpler the form of the geyser-tube, the less is the impediment to the circulation of the superheated water; and in this fact lies the explanation of the difference between constantly boiling springs and geysers. The variations and modifications of the subterranean water-passages, however, must be important factors entering into any complete explanation of geyseric action.

Bunsen's theory, somewhat modified, is probably the best yet proposed, especially that part of it which explains the effect of the rise of water nearly at the boiling-point to an upper portion of the channel where its temperature is in excess of that necessary to cause ebullition. The excess of heat is violently and instantaneously applied to the production of steam. McKenzie, in 1810, also recognized the fact that the sudden evolution of steam was the proximate cause of the eruptions; but he could not account for their periodical production.

The water of geysers and hot-springs has been boiled and reboiled for an inconceivable period, and is freed from air as no other water is. Its cohesion is therefore immensely increased; and this fact, together with the obstruction to the free escape of steam caused by irregularities in the channels, offers a complete explanation of the superheating of the water; and it is well known, that, when water so heated does boil, the production of vapor is instantaneous.

A. C. Peale.

THE AFFINITIES OF RICHTHOFENIA.

Dr. W. Waagen considers the results of his recent study of the new genus Richthofenia Kays. (Anomia Lawrenciana Koninck) so remarkable as to deserve a preliminary notice (*Rec. geol. surv. India*, xvi. 1). Mr. Barrande and Professors Valérin and Möller were of opinion that this fossil was more nearly related to the corals than to any other class of animals, while Professors Zittel and Lindström seemed to be in favor of the view that it was a brachiopod. In favor of the latter view, the microscopic structure of the shell is the most important point. Its silky lustre is identical with that of Productus, though this seems to be effected by different means. In the shell of Productus it is caused by obliquely ascending prisms, whilst in Richthofenia it depends apparently on the fine lamination of the shell, as in Placuna or similar genera. Of great importance is the prismatic structure of the single laminae of which the shell of Richthofenia is composed. Such a prismatic structure is chiefly characteristic of mollusks and molluscoids. Dr. Waagen has never yet observed this structure in corals. In Calceola sandalina, which seems the most kindred form among corals, a microscopic section through the larger valve showed well its radial septa ; but all these septa exhibited a granular, not a prismatic structure. The punctation of the shell is very similar to that of Productus, and so are the hollow root-like tubes which penetrate the shell-substance of the larger valve, and adhere to other bodies. The smaller valve can also be very well compared to the same valve of Productus, although it is doubtful whether the thick parallel ridges on the hinge-line of this valve of Richthofenia can at all be compared to a cardinal process, and whether the impressions on the valve can be taken as muscular impressions. Reniform bodies are most certainly absent. Nevertheless, among the brachiopods, the Productides are the only ones to which the genus Richthofenia might stand in any relation.

Richthofenia possesses certain points of resemblance with rugose corals, — the irregular partitions in the lower part of the larger valve ; the columella-like portion, which is divided off by three vertical septa ; these septa themselves, which can well be compared to the primary and the two lateral septa of a rugose coral ; the cellular structure of the shell ; the septa-like ridges on the outer wall of the animal chambers, which are in connection with the hollow canals which pierce the substance of the shell ; and the tortuous tubes themselves, into which the canals are prolonged on the outer side of the larger valve. There can be no doubt, that on first inspection, ignoring the silky lustre of the shell, one would be far more likely to regard this fossil as a coral than as a brachiopod.

The points of similarity between Richthofenia and the Rudista, chiefly Hippurites, are not very numerous. If we make a section of Richthofenia from the hinge-line to the opposite wall, so as just to touch the median vertical septum, we obtain a figure very similar to what a Hippurites shows when cut so as to touch the first columellar fold. Another point of similarity consists in the direction of the prisms, of which the substance of the shell is composed. The Rudista differ from all the other groups of Pelecypoda in having the prisms of the outer shell arranged vertically ; i.e., longitudinally to the whole extension of the shell. The same is the case in the median shell-layer of Richthofenia. A third point of great importance exists in the pallial impression which is common to Richthofenia and the Rudista ; and, finally, it is not quite certain that the sinuations of the large valve of Richthofenia on both sides of the hinge-line, which stand in so close a connection to the lateral vertical septa, may not be regarded as the beginning of the infoldings of the shell, so characteristic of the Rudista. The distance in time between Richthofenia, which comes probably from the limits between the carboniferous and Permian formations, and the Rudista, which are for the most part upper cretaceous, is so enormous, and the absence of every connecting-link so complete, that a close affinity between the paleozoic and the cretaceous forms should not be expected. It will therefore only be possible to prove the connection between the present fossil and the Rudista, when further members of such a developmental series are discovered.

As the case now stands, it will be most prudent, in accordance with the microscopic structure of the shell, to consider the fossil as something like a brachiopod. As far as Dr. Waagen's opinion goes, he is convinced that Richthofenia is a member of a series, which, branching off somewhere from the rugose corals, has reached in Richthofenia a brachiopod-like stage, and is going to terminate its career as a Pelecypod, as one of the Rudista. But opinion is nothing in science, and proofs are every thing. As yet, it cannot be positively denied that Richthofenia may be a predecessor of the Rudista.

J. B. Marcou.

THE GREENWICH OBSERVATORY.

Among the leading points referred to in the report of the astronomer royal, W. H. M. Christie, F.R.S., to the board of visitors of the Royal observatory, Greenwich, read at the annual visitation on June 2, are the following: —

Besides the regular subjects of observation with the transit-circle, — the sun, moon, planets, and fundamental stars, — a new working-list of 2,600 stars, comprising all those down to the sixth magnitude inclusive, and not observed since 1860, has been prepared, and was brought into use at the beginning of March. The entire number of transits observed with this instrument during the year was 4,188; determinations of collimation-error, 354; determinations of level-error, 323; number of circle-observations, 4,485; determinations of nadir-point, 298; reflection-observations of stars, 484. Comet *a* 1882 was observed seven times on the meridian, and comet *b* 1882, three. The routine reductions of all the observations with this instrument are reported in an extraordinary state of forwardness. From the beginning of this year, a correction of $-0''.39$ has been applied to the results of the nadir-observations to make them agree in the mean with the results of the reflection-observations of stars. This discordance was insignificant in 1878, and is on the increase: its source has not yet been traced. Three determinations of flexure have been made during the year. The correction for $R-D$, the error of assumed co-latitude, and the position of the ecliptic, have been investigated for 1882. The value for the co-latitude, from the observations of 1882, is 38° 31′ 21″.93. The correction to the tabular obliquity of the ecliptic is + 0″.44. The mean error of the tabular right ascension of the moon, from observations with the transit-circle, is + 0ˢ.82.

The observations of the moon with the altazimuth have been restricted to the semi-lunation between last quarter and first quarter; and some limitations have been adopted in the computations which render the reduction of observations with this instrument comparatively light. The moon's diameter has been measured thirty-three times, counting measures in both co-ordinates with the transit-circle and the altazimuth.

A very valuable addition has been made to the instruments of the Royal observatory by the gift of the Lassell two-feet reflecting equatorial, generously presented by the Misses Lassell. This is the instrument with which the Saturnian satellite Hyperion was discovered in 1848. It was removed from Maidenhead early in March, and has been suitably mounted in the grounds of the Royal observatory. The telescope has two large mirrors available for use; and the astronomer royal contemplates attaching one of them to the tube of the 'south-east equatorial,' which has a firm mounting and a perfect clock-work, and employing it for spectroscopic and photographic work. The Lassell telescope itself is well suited for the observation of faint satellites and comets which are beyond the present instrumental means of the observatory.

The observations of the solar eclipse of 1882, May 17, with the south-east equatorial, have been completely reduced, and the final equations solved.

Spectroscopic observations during twelve months have been somewhat restricted through the pressure of photographic reductions at the time of a maximum of sun-spot frequency. The solar prominences were observed on eight days, and four sun-spots were examined on eight days with reference to broadening of lines in their spectra. The spectrum of the great spot of 1882, Nov. 12–25, showed some remarkable reversals of the lines of hydrogen and sodium, and extraordinary displacement of the F line.

As regards determinations of motion of stars in the line of sight, a hundred and forty-two measures have been made of the displacement of the F line in the spectra of twenty-three stars, and twenty-six measures of the line b_1 in nine stars. The observations of Sirius during the past winter tend, on the whole, to confirm the impression that the rate of recession of this star had diminished progressively since 1877, and that its motion is now on the point of being converted into one of approach.

The spectrum of comet *a* 1882 was examined on three nights; that of the great comet *b* 1882, also on three nights; and that of comet *a* 1883, on one night. The spectrum of the first-named object showed the yellow sodium-lines with great brilliancy just before perihelion passage. The spectrum of the aurora was also examined in 1882, Nov. 17. The spectroscopic observations of all kinds are completely reduced to 1883, May 20.

During the year ending at this time, photographs of the sun were taken on two hundred days, and three hundred and thirty-nine plates have been selected for preservation. The sun's disk was free from spots on seven days; and, since the extraordinary outburst of last November, the sun has been comparatively quiescent. The astronomer royal proposes soon to employ a modified photoheliograph for this work, so as to obtain photographs of the sun eight inches in diameter instead of four. The measurement of a large number of Indian and other photographs of the sun, required to fill gaps in the Greenwich series, has been completed, these photographs having been received from the Solar physics committee.

The course of the magnetic observations has remained the same as in former years. Improvements have been made in the methods of photographic registration. There has been considerable magnetic activity during the year. The disturbances of November last are to be detailed graphically in the 'Greenwich magnetic results for 1882.' Particulars of magnetic disturbances are regularly communicated to the *Colliery guardian* newspaper, for the information of mining surveyors.

The mean temperature of 1882 was 49°.6, or 0°.1 lower than the average. The highest air-temperature was 81°.0, on Aug. 6; and the lowest, 22°.2, on Dec. 11. The mean monthly temperature was above the average from January to May, then below until September, and differed little from the average during the remainder of the year. The mean daily motion of the air was 306 miles, 27 miles greater than the average. The greatest daily motion was 758 miles, on Nov. 4; and the least, 30 miles, on Dec. 11. The greatest hourly velocity was 64 miles, Oct. 24. The number of hours of bright sunshine, as recorded by Campbell's sunshine instrument, was 1,245; that is, 40 hours above the average of the five preceding years. The rainfall of 1882 was 25.2 inches, slightly above the average.

In conclusion, the restriction in the observations of the moon with the altazimuth enables more attention to be given to observations with the equatorials. Two observers are now available for spectroscopic observations during the coming year. Mr. Christie characterizes the past year as, in some slight degree, one of transition, and preparation for future work. Some administrative changes have been made; but the regular course of observation and reduction has not been disturbed, and the standard meridian observations have been maintained in full vigor.

LETTERS TO THE EDITOR.

Impregnation in the turkey.

WHEN I was a boy, my father used to send me to some of the neighbors with our turkey-hen, and we left her there with the cock a day or so. Either this, or we would borrow a cock for a day or so, and turn him with our hen. This was not only for one year, but our custom; as we never wintered a turkey-cock, and we did raise turkeys by this process. There was no possibility of the turkey-cock getting with our hen after the contact mentioned above. I did not know that this fact was still unknown to people. What is still a question that I should like settled by experiment is, whether the spermatozoids are retained somewhere in the oviduct until the eggs reach a certain stage of development, or whether they at once impregnate the eggs. W. MANN.

Potsdam, N.Y., July 5.

[We give place to the foregoing extract from Mr. Mann's letter, referring to Mr. Shepard's communication in No. 20, p. 576, on the same subject. There are probably many species of birds in which one connection with the male suffices to impregnate a whole batch of eggs. That the turkey, like the common hen, is one of these, is a fact which hardly requires further confirmation. There can be little question that the spermatozoids are retained in the oviduct, as in other animals, and the eggs impregnated as they successively mature.]

Macloskie's Elementary botany.

The review with which you favor my Elementary botany catechises me as to whether I am sure that the seeds of Lepidium emit mucilaginous threads. Permit me to answer that I am sure, having made the experiment a dozen times. Violets, besides the orders cited by the reviewer, prove that the statement as to cymose flowers being actinomorphic requires modification. I sympathize with the objection to the terms 'exotest' and 'endotest;' but the terms 'primine' and 'secundine' are bewildering to authors as well as students, and give priority to the part which is in most cases a result of secondary differentiation; 'tegmen' is obsolete, and the whole subject of the development and structure of the seed-wall requires revision: hence the provisional use of terms which, though hybrid, are easily understood, and not likely to mislead the young. G. MACLOSKIE.

July 10, 1883.

[We conjecture that Professor Macloskie had mixed in his mind, or at least in his statement, two different cases, — one, that in which the wall of the surface-cells of the seed-coat, changed into a substance which swells into mucilage upon wetting, contains a spiral thread, as in Collomia; the other, in which there is no contained thread. According to our observations, the seeds of Lepidium belong to the latter: hence the 'catechism,' which was intended to call attention to a possible oversight. We have to-day verified our observation upon seeds of Lepidium ruderale. Perhaps Professor Macloskie will kindly indicate the species in which he found the threads. — REVIEWER.]

Primitive streak of vertebrates.

Dr. Strahl of Marburg has had the kindness to write to me concerning the abstract of his researches (SCIENCE, i. 521). A part of his letter contains an explanation which I shall be glad to have published in justice to Dr. Strahl. Translated, the passage is as follows: —

"As regards the esteemed remark at the close of the abstract, — that I have declared erroneous Balfour's comparison between the primitive streak and neurenteric canal on one side, and the blastopore of Amphia and fishes on the other, — the remark may be due to a misunderstanding. So far as known to me from his descriptions, Balfour placed the neurenteric canal at the anterior end of the primitve streak. But, as I have shown in my paper, the neurenteric canal originally lies in the middle of the primitive streak. The object of my demonstration is to show that the premises from which Balfour starts do not agree with the observations: this, I believe, was accomplished. This would also decide the second point made by you, — that my argumentation against Balfour was defective."

I am much indebted to Dr. Strahl for his letter, and I think others will value his short statement of his position. CHARLES SEDGWICK MINOT.

In an Indian grave.

In an Indian grave in Santa Barbara county, Cal., the writer found a beautiful specimen of doubly terminated limpid quartz, with a cavity half an inch long containing water or some other fluid. It was about four feet below the surface, and had been carefully deposited with many other stone implements, and was doubtless highly prized by its aboriginal owner. STEPHEN BOWERS.

WARD'S DYNAMIC SOCIOLOGY.

II.

IT is proposed to show the relation of Mr. Ward's publication to current thought.

The law is composed of the rules of conduct which organized society endeavors to enforce. The law, therefore, represents the quantity and quality of regulation, or, in other words, of government, which the people of the state in their corporate capacity deem necessary for their welfare. With respect to the amount and kind of government (i.e., of regulation, i.e., of law) which the best interests of society require, there is a very wide divergence of opinion between the chief publicists of civilized nations and the people themselves as they are represented by law-making bodies. The publicists tell us we are governed too much; but the people are demanding more government, and, in obedience to this demand, law-making bodies are rapidly extending the scope of law. The careful observer of the progress of government, who is at the same time a careful reader of opinion presented in the larger body of works on state craft, in the more carefully prepared dissertations on this subject appearing in the great reviews, and in many of the best editorials of the daily press, is astonished at the extreme conflict between opinion and practice.

There are two classes of law-making bodies, — courts and legislatures. The growth of law through the courts is almost unrecognized by the people at large; yet its development by this agency is perhaps more rapid than by legislation. The legal principles enunciated in the decisions of a system of courts such as we have under the general government and in the several states are rapidly developing to meet the demands of the vigorous growth of civilization. Some months ago the public prints announced a decision of the supreme court of California which well illustrates this statement. In more than two-fifths of the area of the United States all agriculture is dependent upon artificial irrigation. In 1866 the Congress of the United States, in order to promote mining industries in this region, and incidentally to promote agriculture, enacted a statute giving to individuals and corporations the right to take the water of the running streams of that country from the natural channels in which they run, and use the same for mining and agricultural purposes. Now, the nature of this use is such that the water itself cannot be returned to the natural channels to be used again; and by this law the antecedent common law relating to riparian rights was repealed. As the agricultural interests of the country were developed, it was soon discovered that all agricultural operations were under the control of water companies; for these companies claimed ownership to the water, and the right to use it themselves or to sell it to whom they pleased. But the decision mentioned above was to the effect that these companies possess only the water-ways, the canals and hydraulic appliances connected therewith; that they are common carriers of water, and are themselves subject to the law relating to common carriers. By reflection it will be perceived that this decision will affect vast interests, and deeply influence the daily life of thousands, and eventually of millions, of people. This serves to illustrate the nature of the court-made law, which is so rapidly growing, and affecting in a multitude of ways the relations of men, and restricting the rights of the few for the benefit of the many, which is in the very nature of law. In the above statement it will be observed that the initial change in the law was the statute of 1866. So the national and state legislatures are constantly engaged in making new laws for the government of the people; and this, in the main, ever in obedience to popular demand.

Such is the practice. The legislature stimulates the court, and legal decisions incite new legislation; and thus it is that the public men of this country and of other civilized nations devote their energies to the development of government by devising new laws for the regulation of conduct, and creating new offices for the administration of law.

Again: in every community there is a body of good and earnest people demanding reform, or devising methods for the improvement of mankind in diverse ways, — for the relief of the unfortunate, for the education of the masses, to diminish suffering, crime, and ignorance; and the energies of these people, exerted everywhere, in season and out of season, create a sentiment that law-making bodies cannot ignore.

Yet, in opposition to all this, the publicists ask for less government, and say, 'Let society alone.' This theoretic opposition to the course of progress, manifest in the development of institutions, arises from the standpoint, or phase of the philosophy of evolution, at which our thinkers have arrived. The laws of biologic evolution are applied to sociology. The philosophy of science, which is but inchoate, is adjudged to be complete, and principles that require restriction are held to be universal.

In biologic evolution the cause of progress is recognized as the survival of the fittest in the struggle for existence; and this has been widely accepted as the cause of sociologic progress, and Herbert Spencer is the prophet of this philosophy. As set forth by him and his large following, progress is secured by an inexorable law of nature, which brooks no interference; and the efforts of mankind to improve the condition of mankind do but retard the natural process; and the proper sphere of government is the direct suppression and punishment of crime, and that only. It is from this postulate that the theorists are antagonizing the practice of all the legislatures and courts of civilization. Though Mr. Ward does not state the problem as above, yet his book is written to controvert the Spencerian and generally accepted theory, to present a new philosophy of society which shall be sufficient warrant for the course pursued by practical statesmen and jurists, and to support the earnest people of the world in their efforts to benefit the race. His postulate, though stated in other terms, is essentially this: that social progress is due to the struggle for happiness, and the adoption of that conduct which secures happiness; and that the process, instead of being natural and genetic, is artificial and teleologic; that men devise methods for securing happiness, and gradually attain their ends.

Mr. Spencer looks upon society as an organism, and in this he is followed by Mr.

Ward; but the former author makes it the central point of his sociology, around which all other facts are gathered, and he elaborates a system of analogies with biologic organization, as if, in fact, they were homologies. It will perhaps be nearer the truth to speak of a state, rather than society at large, as an organism.

The organization of mankind is twofold, — activital and regulative. By the activital organization, which is usually discussed in works on political economy under the title 'division of labor,' the industries and other occupations of mankind are parcelled out to individuals and corporations; so that a man, in working for himself, works for many others, and an interdependence of parts in the social organism is thus established. For the successful operation of the activital organization, the regulative organization is established, which results in government, with its three co-ordinate departments, — executive, legislative, and judicial. Without division of labor and governmental regulation, the individuals of the human race would be entirely discrete; with them, mankind is organized into societies which we call 'states.' In so far as the people of one state are related to the people of another through their industries, there is an inchoate organization of state with state, which can only be completed by the consolidation of such states. Though Mr. Spencer devotes an inordinate space to the demonstration of the organization of society, he fails to discover, that, in so far as organization is accomplished, the method of biologic progress by the survival of the fittest is repealed. In the struggle for existence, state comes into competition with state; and to this extent the biologic law of the survival of the fittest applies. But in the relations of the interdependent parts of states, i.e., the different classes of people existing in a tribe or nation, the law of the survival of the fittest in the struggle for existence no longer applies; the unfit do not succumb; the welfare of each class (i.e., each organ, interdependent part) depends upon the welfare of each other part, — of the whole. There may be a competition for leadership, or for eminence in other respects, but not for existence.

Those who adopt the Spencerian theory believe that they find confirmation of their doctrine in the history of legislation. In modern times, since the differentiation of executive, legislative, and judicial organs and functions in government, legislation has often been unwise, and laws have failed to secure the purposes for which they were enacted. In this branch of human endeavor it would be strange if it were everywhere and at all times characterized by wisdom, when man has so frequently failed in other effort.

But beside the general failure for lack of wisdom, there has been failure for certain special reasons. Early law was common law; later law is in part statutory. In the change from the former to the latter, many great mistakes have been made. The body of law existing in a state, be it tribal or national, is the chief body of the ethics of the people of such state. But among such people there are ethical rules not found in the law, but held by individuals in a greater or less number. These non-legalized ethics are of two kinds, — first, those which have passed from the law, and are yet held in veneration by a part of the people; second, those which the more advanced minds are endeavoring to establish. The first are obsolete; the second, inchoate. Much of the law which Spencerian philosophers have used to illustrate the folly of legislation has been in instances where an attempt has been made to revive obsolete common-law principles by effective statutory law. Mr. Spencer's illustrations are chiefly of this class; and he has been followed by many a writer. This source of disaster can be avoided, not by refusing to legislate, but by a proper knowledge of the course of progress in social evolution. This course of evolution has not been, as Mr. Spencer postulates and elaborately discusses, from more regulation to less, from militancy to industrialism, but from less to more law, and from non-essential to essential regulation. When diseases were believed to be the work of evil spirits, or to result from the practice of sorcery, the relations of men to supposed spiritual beings were regulated, and witchcraft was punished; but, when diseases are discovered to be due to unwholesome conditions of environment, sanitary laws are enacted. And in like manner in every department of government the change is going on. Laws are sociologic inventions, analogous to the technologic inventions of the industries. Along with much failure there is much success. As the progress of industries would cease were no new methods devised, so the progress of society would end if new law were not enacted.

Dynamic sociology, as presented by the author, is the philosophy of human endeavor, and the justification of man in his effort to to improve his condition. Those persons, and they are many, who are actively engaged in the promotion of institutions and regulations for the benefit of mankind, will find in it philosophic hope; while those who are opposed to the course of practical events appearing in public affairs cannot afford to ignore their strongest opponent.

The evolution which is discovered everywhere in nature, to be properly demonstrated, must have its explanation set forth in three parts. First, it must be explained why there is change, for without change there can be no development; second, it must be shown by what agency change results in progress, for change to inferior or co-ordinate conditions is not evolution; and, third, what is the course of progress, for, if there is progress, it must be in some direction that can be determined, and thus science becomes prophetic.

Of the three departments of sociology, — namely, the causes of social change, the causes of social progress, and the course of social progress, — the work under consideration, as its name indicates, is devoted to but one, — the cause of social progress; though it incidentally discusses many of the subjects of evolution in other branches of science, and the author ultimately reaches the conclusion that education is the chief means to secure social progress, and thus secure human happiness.

SIEMENS' SOLAR ENERGY.

On the conservation of solar energy: a collection of papers and discussions. By C. WILLIAMS SIEMENS, F.R.S., D.C.L. London, *Macmillan & Co.*, 1883. 20+111 p. 8°.

THIS is a collection of the original paper read before the Royal society by Siemens, and the criticisms from Fitzgerald, Faye, Hirn, Archibald, and others, together with the replies of Siemens.

The theory, well summed up on p. 22, supposes that space is filled with aqueous vapor and carbon compounds; that these, at low pressures, are dissociated by the radiant energy of the sun; that the dissociated elements are drawn into the sun at its poles, unite, and generate heat sufficient to give a temperature of about 2,800° C.; and that the aqueous vapor and carbon compounds formed are again thrown off by centrifugal force at the sun's equator.

As evidence of the presence of carbon vapors in space, Siemens refers to the analyses of meteors, which in some cases have proved that hydrocarbons were a component of the meteoric mass, and again to the work of Abney and Langley on the absorption of the radiant energy of the sun.

The dissociation of vapors at low tensions is a point which seems to be well established. One of the earliest proofs is given in Prof. J. Willard Gibbs's paper on the equilibrium of heterogeneous substances.[1] He shows, that in a mixture of gases, as of oxygen, hydrogen, and vapor of water, in which the vapor is formed with a decrease in volume from that of the components, it is possible to assign a value to the tension such that the mixture may be in a state of dissipated energy; i.e., in such a condition that the energy of the system is a minimum for its entropy; and that any change in energy can be brought about only by work done by some outside system and in proportion to that outside work. In such a state, nothing of the nature of an explosion could be caused by an electric spark: the elements would cease to show the phenomenon of chemical affinity. Willard Gibbs writes, "It may, indeed, be true, that at ordinary temperatures, except when the quantity either of hydrogen or of oxygen is very small compared with the quantity of water, the state of dissipated energy is one of such extreme rarefaction as to lie entirely beyond our power of experimental verification." In the formula from which these results are deduced, the ratio occurs of the amounts of the components to that of the compound, these amounts being raised to small powers. This explains the qualification as to the amount of components which may exist in a free state.

This last condition may have an important bearing on the possibility of the truth of Siemens' theory; for, although Gibbs has shown that dissociation may occur in rarefied vapors, still the amount of the dissociation is limited unless the rarefaction be very great.

Some two or three years ago Professor Ogden Rood succeeded in getting experimental evidence of dissociation in rarefied gases at ordinary temperatures, but has never published his results.

Dr. Siemens gives, on p. 13, what evidence he early obtained of dissociation of gases in vacuum tubes under the influence of sunlight. What he has done since may be found from an account of his recent lecture at the Royal institution (*Nature*, May 3). Objections to the theory are well put by Fitzgerald when he asks (p. 41) "how the interplanetary gases near the sun acquire a sufficient radial velocity to prevent their becoming a dense atmosphere round him; why enormous atmospheres have not long ago become attached to the planets, notably to the moon; why the earth has not long ago been deluged when a constant stream of aqueous

[1] Proc. Conn. acad. sc., iii.

vapor, that would produce a rain of more than thirty inches per annum all over the earth, must annually pass out past the earth in order to supply fuel to be dissociated by the heat that annually passes the earth; and why we can see the stars, although most of the solar radiations are absorbed within some reasonable distance of the sun."

It can be hardly looked on as a strong answer to the first question, that "the gases, being for the most part hydrogen and hydrogen compounds, have a low specific gravity as compared with the denser gases forming the permanent solar atmosphere. On flashing into flame in the photosphere, their specific gravity would be vastly diminished, thus giving rise to a certain rebound action, which, coupled with their acquired onward motion and with the centrifugal impulse they receive by frictional contact with the lower atmosphere, constitutes them a surface-stream flowing from the polar to the equatorial regions, and thence into space." It is certainly hard to understand why the atmosphere of any member of the solar system should not be made up of the gases of interplanetary space in the same proportions in which they may exist in such space, if there is the free circulation called for by Siemens' theory.

Faye objects that the presence of such a resisting medium in space as the vapors is not to be accepted, with our present knowledge, and that the centrifugal force at the sun's equator is far too small for the action required.

Hirn, starting with the supposition that the sun's temperature is 20,000° C., writes, that, although the dissociated gases might unite in the chromosphere, they would, on passing down through the sun's atmosphere, be again dissociated, and absorb as much heat as they had given out on combining. To this, Siemens might have answered that the gases would again combine on passing off at the equator.

The discussion of the theory at the time of its first statement was most earnest; but, in spite of the ingenuity displayed in its elaboration, it as yet cannot be accepted as probable.

INSPIRED SCIENCE.

Eureka; or, The golden door ajar, the mysteries of the world mysteriously revealed. By ASA T. GREEN. Cincinnati, *Collins*, 1883. 141 p., portr., cuts. 16°.

THE publisher acts as editor of this book, interspersing his own chapters among the author's in an odd fashion. The florid periods of the one form a curious setting for the rough, ungrammatical language of the other.

The author has 'revelations' of a 'wonderful knowledge' which he obtained, partly in the woods, and partly in Oil City, and desires to impart them to scientific men. We will offer them a bit.

"If we would lay a telegraph-wire down down (*sic*) from every point of the earth, and of water, and all points telegraph at one time to a given point, the result would be to find that the atmosphere was going as fast as the earth, and the earth as fast as the atmosphere. *Thus you see* it is the atmosphere that carries the earth around. . . .

"Third reason why the earth is round; namely, because the mountains are up. If the earth was flat, the mountains would be just as liable to be down as up, but as the curvature of the earth is up, hence the mountains are up. . . .

"If sound travels by vibration, as science teaches, and science teaches that vibration creates heat, that if a cricket should stand on one end of a solid slabstone and rub his wings together, why is it that the vibration with the particles of stone does not completely melt the stone in ten minutes? I deny the hypothesis."

'Wonderful knowledge,' indeed!

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Points of inflection. — Let $U = x^{\alpha}y^{\beta}z^{\gamma} + ku^{\delta} = 0$ be an equation in homogeneous co-ordinates; x, y, z, are the sides of the triangle of reference, and $u = ax + by + cz$; $\alpha, \beta, \gamma, \delta$, are integers such that $\alpha + \beta + \gamma = \delta$; a, b, c, are given quantities, and k a variable parameter. For $\alpha = \beta = \gamma = 1$, this equation gives a system of cubics having, as is well known, their points of inflection distributed by threes upon three right lines; viz., the three real points of inflection upon u, and the remaining six points, in threes, upon two imaginary lines.

The author, M. A. Legoux, proposes to consider the general case of curves of the order δ. The three sides of the triangle of reference are tangents to all the curves of the system in the points where these sides meet the line u. The order of contact is $\delta - 1$: if δ is even, the curve in the neighborhood of the point of contact lies on one side of the tangent; if δ is odd, the curve here cuts the tangent, giving a point of inflection of a higher order. M. Legoux shows that the proposed curves have imaginary points of inflection, which are distributed upon two conjugate imaginary right lines which are independent of the value of k. If δ is even, there are no other inflections; but, if δ is odd, there exist three real points of inflection upon the line u, so that in the last case there exists, as in the case of cubics, an inflectional triangle. — (*Nouv. ann. math.*, Feb.) T. C. [105

ENGINEERING.

Electric-lighting machines on shipboard. — More than a dozen of the steamers plying between New York and Liverpool are fitted up with electric-lighting machinery. Probably three times as many are so fitted out on the various other lines of ocean-going steamships. The British steamers are largely supplied with the Siemens and Swan apparatus, but the other systems are well represented. The electric-light apparatus of the Arizona consists of two Siemens compound dynamos, each sufficient to supply current to three hundred high-resistance Swan lamps. They are driven by a pair of 'Caledonian' engines of nine and a half inch cylinders and fourteen inches stroke of piston. The two machines are mounted upon a common foundation, and are set in such manner that the driving-pulleys do not interfere with each other. The belts are tightened by moving the machines away from each other; they are formed of one continuous rope carried around each pulley ten times. Both cabins, and the steerage as well, are lighted by these machines. — (*Engineering*, May.) R. H. T. [106

New engine for electric-lighting. — Mr. E. D. Farcot has designed a new form of compound engine for electric-lighting machinery. It consists of two cylinders, the larger set above the smaller. The space between the two pistons is undivided, and is in communication with the interior of the engine-frame, and is never put in connection with the steam-supply pipe. The steam first enters the small cylinder, and is thence exhausted into the large cylinder, thus driving the pistons, which are both on a single rod, in opposite directions by a system of intermitted expansion. The engine is thus seen to be of the 'Wolff system.' The space between the two pistons is made to communicate with the larger space in the frame, merely to secure a reduced variation of uncounterbalanced pressure. No stuffing-box is needed in this engine in any inaccessible part of the machine. The valve-gear is of the plainest possible description, and the whole engine is built with a view to simplicity and small cost in construction and operation. It is intended to be driven up to four hundred revolutions per minute. — (*Publication industrielle*, May.) R. H. T. [107

Steam-jackets for steam-engines. — Herr Heim reports to the German society of engineers the results of experiments to determine the economy to be derived by the addition of steam-jackets to various forms of steam-engine. He finds that a six-horse power portable engine, unjacketed, demanded an excess of thirty-five per cent over the theoretical quantity of steam that should have been required to do the work; an eighteen inch Wheelock engine required the same excess over the calculated quantity. Both were non-condensing. Condensing-engines experience a still greater loss due to internal 'cylinder condensation.' Engines expanding ten times demand seventy-four per cent excess; when cutting off at one-fifth, sixty-two per cent; and expanding three times, fifty-five per cent more than the calculated amount when they are unjacketed. By adding a jacket, he concludes that the loss can be reduced to sixty-four, fifty-four, and forty-eight per cent. The effect of increase of piston speed is similar to that of adding a jacket. An engine at three feet, and at seven feet piston speed per second, gave a record of loss amounting to ninety-six and seventy per cent. The addition of the condenser causes increase of this loss. A twenty-inch non-condensing engine, working at five atmospheres pressure, was provided with a condenser, and, while the power was increased one hundred and forty per cent, the waste was increased from forty-two to sixty-two per cent. A hoisting-engine, working intermittently, exhibited a loss of a hundred and forty-two per cent of the weight of steam utilized. — (*Mechanics*, June.) R. H. T. [108

AGRICULTURE.

The gases evolved during the conversion of grass into hay. — In a series of experiments on this subject, conducted by Dr. P. F. Frankland and Mr. F. Jordan, freshly-cut grass in quantities of five grams each was allowed to stand in a glass tube over mercury. The glass tube was filled with air, inert gases, and experiments were also performed *in vacuo*. In air all the oxygen was absorbed at the end of three days, and 46% of carbonic dioxide was evolved. At the end of thirty days the percentage of carbonic dioxide reached 85.33, requiring a corresponding amount of oxygen, which must have come from the substance of the grass itself. Nearly pure carbonic dioxide was evolved in an atmosphere of the same gas, and a higher percentage seemed to be given off in darkness than in sunlight, although the authors were somewhat in doubt on this point. In an atmosphere of pure oxygen, the latter was absorbed completely in seven days, and the evolution of nitrogen ceased when the oxygen disappeared. When the experiment was conducted in an atmosphere of hydrogen, 21.11% of this gas was replaced by carbonic dioxide at the end of three days. It thus appears that certain constituents of the grass undergo a rapid process of oxidation, and that nitrogen is evolved as long as the atmosphere contains free oxygen. The decomposition-products of grass, when allowed to stand under water, were also examined. The grass was first soaked in distilled water, and the dissolved air removed with a Sprengel pump. Carbonic dioxide formed about 90 %, and hydrogen about 9 %, of the gases collected at the end of thirty days. No gas was evolved when the formation of bacteria was prevented by the addition to the water of phenol or mercuric chloride. As the other products of the fermentation, acetic and lactic acids, and probably propionic acid, were identified. — (*Journ. chem. soc.*, June, 1883.) C. F. M. [109

Absorption of moisture by soils. — Fisher finds that, contrary to Knop's statement, the amount of hygroscopic moisture retained by a soil varies greatly with the amount of moisture present in the air, as well as with the temperature. At temperatures ranging approximately from 20° to 30° C., about half as much water was retained in a half-saturated as in a saturated atmosphere. As the temperature was raised, more water was absorbed from the saturated atmosphere, but less from the half-saturated one. — (*Rep. Cal. college agr.*, 1882, 52.) H. P. A. [110

Influence of organic manures on temperature of soil. — In experiments on this subject, F. Wagner finds that organic manures raise the temperature of the soil to an extent increasing with the quantity of the manure, the temperature of the soil, and its moisture, so long as the latter is not in such excess as to hinder access of oxygen to the organic matter, or to cool the soil too much by its evaporation. Porosity and ready decomposability on the part of the manure favor the action. The increase of temperature is greatest at first, may continue from four to twelve or more weeks, but under practical conditions is too small to be of much significance. — (*Forsch. agr. phys.*, v. 373.) H. P. A. [111

Moisture of the soil. — In pot-experiments with peat, Heinrich obtained the largest crop when the peat contained sixty per cent of the total quantity of water which it was capable of containing. Earlier experiment by Hellriegel on sandy soil gave nearly the same results. When the moisture of the peat fell below twenty per cent of its water-capacity, no crop was obtained, while in case of sand a small crop was obtained when the moisture was only ten per cent of the total water-capacity. — (*Bied. centr.-blatt.*, xii. 109.) H. P. A. [112

GEOLOGY.

Lithology.

Cleopatra's Needle. — In a paper by Dr. P. Frazer is given a description of some thin sections of the New-York obelisk, made by Prof. A. Stelzner of Freiberg, accompanied by four lithographic plates. The rock is composed of fresh microcline, showing in polarized light its characteristic grating; oligoclase, somewhat decomposed, and showing fine twinning striation; quartz in grains and granular aggregates, containing fluid cavities, trichites, and hematite plates; light green hornblende with irregular outlines; biotite in large brown, translucent scales; titanite in numerous small yellowish-red grains; water-clear acicular apatite crystals; magnetite in opaque irregular grains and in octahedrons; minute zircon crystals; yellowish-green needles of epidote and viridite. A granite from Germantown was regarded as similar to the Syene granite. The former is composed of microcline, plagioclase, quartz, hornblende, biotite, muscovite, titanite, etc. Frazer gives the literature of the subject. — (*Trans. Amer. inst. min. eng.*, *Boston meeting.*) M. E. W. [113

Journalistic lithology. — A weekly journal was established last year in England on the peculiar plan of publishing descriptions of microscopic slides, with figures of the same, while duplicates of the described preparations were to be sent to every subscriber. This method, if under the direction of competent specialists, would serve as a valuable means of home training for those who are unable to place themselves under the direct instruction of competent teachers. It promised twenty-six histological, eighteen botanical, and eight lithological sections a year.

The lithological descriptions, so far, have embraced the following rocks: pikrite, dolerite, diabase, red and white syenite, and serpentine, with some bibliographical lists. While the journal contains some matter of interest to lithologists, it is, on the whole, a disappointing and unsafe guide for a student. In some cases the style of the lowest grade of 'popular scientific lecturers' has been adopted; and the phrase 'plugs of exosmotic transference,' used for veins, is too good to be lost. — (*Studies in microscopical science, London*, 1882–83.) M. E. W. [114

METEOROLOGY.

Sun-spots. — At the university observatory at Rome on 269 days in 1881, and 290 in 1882, Tacchini has made observations of sun-spots. He shows that in 1882 there was an increase in spots over 1881. The mean daily number by months was, in 1881, 19.55, and, in 1882, 22.57. There were peculiar maxima in the number in April and November, 1882. Taking each period of constant activity in the daily observations in 1882, a second maximum and minimum period appears at the half sun's rotation. For the faculae we also find that the increase is less with the growth of the spots; the yearly mean in 1881 being 88.36, and, in 1882, 81.55. It is believed from the character of the sun's activity at the last maximum period, as compared with the present, that the maximum spottedness will occur in 1883. — (*Naturforscher*, May 12.) H. A. H. [115

PHYSICAL GEOGRAPHY.

Artesian wells in Algeria. — In the south of the province of Constantine, Algeria, the boring of artesian wells, begun in 1856, was continued with renewed activity, after the interruption occasioned by the Franco-Prussian war, under the direction of M. Jus. At the end of 1879 the long line of wells following the Wady Rir, between Biskra and Tugurt, included 434 sunk by the Arabs, and yielding 64,000 litres a minute, and 68 bored by the French, yielding 113,000 litres. In the same decade, the number of palm-trees in the oases had increased from 359,000 to 517,000; of fruit-trees, from 40,000 to 90,000; of inhabitants, from 6,672 to 12,827. During the first half of 1880, twelve new wells were bored, yielding 22,000 litres, and, at the end of 1881, the total supply of water from these underground sources was 209,000 litres a minute. — (J. J. Clamageran, *Rev. géogr. internat.*, 1883, 43.) [116

Currents of the Pacific Ocean. — Antisell discusses the general motion of the warm currents of the western and northern Pacific, brings together a number of data not before correlated, illustrates them by maps and diagrams, and comes to the conclusion that, 1°, the warming influence of the North Pacific is the Kurosiwo, the motor power of which is the south-west monsoon, blowing from April to October; and, 2°, that the North Pacific Ocean has practically no northern outlet, Bering Strait affording no real access for ocean-currents into the Arctic Ocean. — (*Bull. Amer. geogr. soc.*, ii. 1883.) W. H. D. [117

The Connecticut River in the glacial period. — Professor J. D. Dana continues his studies on the former lines of flow of the flooded Connecticut at the end of the ice time, and finds evidence, from the height and coarseness of the terraces, that some of the river's waters found their way southward along the Farmington valley (where the Farmington River now runs northward), down the upper course of the Quinnipiac, and thence directly southward along the present Mill River channel, to the Sound at New Haven, and not all the way along the Quinnipiac, as was formerly supposed. — (*Amer. journ. sc.*, xxv. 1883, 440.) W. M. D. [118

GEOGRAPHY.

(Asia.)

New Guinea. — A ten-days' trip inland from Port Moresby, made by W. G. Lawes and two others, with a party of natives, led them over the Veriata Mountain, about two thousand feet high, and up the valley of the Laloke River. From the mountain-summit, they had a fine view of sea and coast, hill and valley, intersected by many winding streams. In the valley, they visited the Rouna Falls, — about two hundred and fifty feet in height, and a hundred and fifty feet wide. The travellers saw many of the natives of the Koiari tribes, and found them all friendly and honest. They are smaller, darker, and more hairy than the coast tribes, and it was not uncommon to find a man with beard and mustache. They have a superstitious belief, that, when a man dies, he has been bewitched by a spirit belonging to a neighboring tribe, who then must pay for the loss: fighting, therefore, always follows the death of a man of any consequence. Fruit is very plentiful and in great variety. Salt is highly prized, and makes a very acceptable present. The native method of getting fire is peculiar: a piece of dry, pithy wood is split a little way, and held open with a stone; some tinder is put in the cleft, and a strip of rattan or bamboo is passed through it, and then pulled rapidly one way and the other till smoke and fire appear. In the 'Sogere' district, the villages consist of only eight or ten houses, and two or three 'tree-houses' which serve as forts. The occupants prepare for an attack by carrying up a supply of stones into the tree-houses; and as they are sometimes over one hundred feet high, and command the whole village, they are not easily taken. Travelling was not easy, as there were numerous streams to cross, and leeches were very plentiful in the wet grass. — (*Proc. roy. geogr. soc.*, v. 1883, 355.) W. M. D. [119

Indian surveys. — A general report on surveys in India during 1881–82, by Gen. J. T. Walker, announces the completion of the triangulation of all India on the lines long ago marked out by Col. Everest and sanctioned by the East India company. The latest part of this Great trigonometrical survey was the eastern frontier series of triangles extending from Assam to Tenasserim, where it was brought to a close on a base line of verification at Mergui. The topographical survey has continued its work in various parts of the peninsula, turning out maps on several scales embracing nearly twenty-five thousand square miles, besides forest and town surveys on large scales. A new survey of the Hoogly is begun, as the existing maps are out of date and on too small a scale for utility in so densely populated and valuable a region.

The chief geographic interest in the volume is found in the reports on trans-Himalayan explorations by trained native travellers, and in the reports of various executive officers of the survey on their districts. — (*Proc. roy. geogr. soc.*, v. 1883, 368.) W. M. D. [120

BOTANY.

Cryptogams.

New Ustilagineae. — Cornu gives an account of the anatomy and germination of the spores in several curious Ustilagineae. Ustilago axicola, Berk. and Curt., is made the type of a new genus, Cintractia, characterized by the formation of the spores in successive concentric circles. The curious Testicularia Cyperi from the United States is figured, and a second species of Leersia is described. The new genus Doassansia, in which the spore masses are surrounded by a peculiar envelope, has one representative from North America which is figured by Cornu. — (*Ann. sc. nat.*, xv. 269.) W. G. F. [121

Zygospores of Mucors. — Bainier has studied the conditions which favor the production of zygospores in Mucors, and finds that the conditions vary in the different species. The absence of free oxygen or of light is not a necessary condition, nor is a deficient supply of nourishment always required for the production of zygospores. Bainier cites a considerable number of cases where he has cultivated different species, and gives the manipulations required in each case for securing sporangia and zygospores; and he adds some observations on the chemical action of certain species. It appears that Phycomyces nitens, which usually grows on fatty substances, which it decomposes, can also be cultivated on cochineal, causing it to assume a deeper color, and rendering it more valuable commercially. Mucor racemosus, and a new species, M. tenuis, are described and illustrated in full. — (*Ann. sc. nat.*, xv. 342.) W. G. F. [122

Phenogams.

Lignification of epidermal membranes. — Besides cutinization, the change which characterizes epidermal cell-walls in general, the exposed wall may undergo two others: it may be converted into mucilage, thereby becoming weakened, or it may be rendered firm by the deposition or infiltration of mineral matters. To these well-known transformations of epidermal cells, Lemaire now adds *lignification*, hitherto supposed to be confined to internal tissues. For the detection of lignine, he uses the useful reagent suggested by Wiesner, phloroglucine. A section of epidermis is transferred from an alcoholic solution of the agent to hydrochloric acid, when the lignified membranes assume a rose color, the other parts remaining unchanged. For purposes of control, similar sections are first treated with either nitric acid or a solution of bleaching-powder, by which reagents, preferably the latter, the lignine is removed. Lemaire has detected lignine in the epidermal walls of Cycads, many Coniferae, and in the petiole of certain ferns. The stomata of gymnospermous plants have been found by him to always have the membranes somewhat lignified. — (*Ann. sc. nat.*, xv. 302.) G. L. G. [123

Mentzelia laevicaulis as a fly-catcher. — Marcus A. Jones of Salt Lake City, acting upon Dr. Gray's suggestion, examined this plant with the following interesting results: "the leaves are thickly beset with coarse hairs, which are furnished with several pairs of barbs pointing downward along them, while the top has an anchor-shaped summit twice as large as the other barbs. These hairs stand so close together that the barbs almost touch. Thickly studding the leaf, were many dead and dying mosquitoes, species of aphis, and other small insects. Some of these were caught by the head; but most of them were held by the proboscis, as their heads were too large to slip between the barbs. All were more or less mutilated, probably by other insects. A sweet fluid was secreted by the leaf, and this attracted the insects. There was no evidence of any digestion going on, as none of the victims could get close enough to the surface of the leaf to be touched by the fluid." — (*Bull. Torrey club*, June.) G. L. G. [124

Elongation of pedicels in Didymoplexis. — Hemsley calls attention to the elongation of the pedicels in these Asiatic orchids after fertilization, by which the ripening capsules are carried up above the decaying vegetable matter in which the plants grow. It is thus quite different from the elongation of the flower-stalks of Arachis and other plants which bury their ripening fruit. What its exact bearing on dissemination may be is not quite clear. — (*Journ. Linn. soc. bot.*, June 6.) W. T. [125

ZOÖLOGY.

Mollusks.

Mediterranean Mollusca. — Dr. J. Gwyn Jeffreys publishes a useful annotated list of species obtained near Crete by Admiral Spratt in seventy to a hundred and twenty fathoms. They are mostly quite minute. Ten new species are described and well figured. One, an extremely minute shell, which might well prove the fry of something larger, is globosely conical, imperforate, and with the pillar angulated and spread out at its base. It is referred to a new genus, Brugnonia, and placed in the Solaridae. A list of Ostracoda and Foraminifera, collected with the shells, is added by Mr. David Robertson. — (*Ann. mag. nat. hist.*, May.) W. H. D. [126

Structure of the shell in brachiopods and chitons. — Van Bemmelen has prepared an English abstract of that part of his Dutch paper which relates to the brachiopods. The principal points of the dissertation are also to be found in the *Jenaische zeitschrift*, ix. h. 1–2, 1883. That part relating to the chitons, which is the more interesting because in a fresher field, has not been made available for students who do not read Dutch. The paper is decidedly sophomorical, containing much that is important but not new, and a little that is new but not important, if we except the opinions of the author. The statement that there is any difference, except in degree, between the structure of the peduncle in Lingulidae and in other brachiopods, will require much more demonstration before it can hope to be accepted; and the principles upon which he includes the greater in the less by placing brachiopods among the chaetopods, would, if carried to their logical conclusion, include man among the Ascidians. — (*Ann. mag. nat. hist.*, May.) W. H. D. [127

Economic mollusks at the Fisheries exhibition. — The catalogue of the economic mollusks exhibited by the U. S. fish-commission at London, prepared by Lieut. Winslow, U.S.N., has just appeared, and forms a pamphlet of 85 pages, containing much information. — W. H. D. [128

VERTEBRATES.

Homologues of the parts of the temporal bones. — M. Lavocat, at the close of his revision of this subject, offers the following conclusions: —

1. That the relations of the squamosal and the zygomatic process in mammals show how ill applied to the oviparous vertebrates are the terms 'tympanic bone' (*os tympanique*), generally applied to the squamosal, and 'squamous portion of the temporal' (*écaille temporale*), given to the zygomatic process. In the oviparous vertebrates the tympanic bone does not exist. 2. That the zygomatic process, always included between the squamosal and the jugal, should never be confounded with the squamosal. 3. That there is a vulgar error relative to the temporal of serpents, in which the superior part of the squamosal has been considered to be the mastoid; while, in reality, the mastoid is invariably situated above or behind the auditory cavity, and is never movable. 4. That in birds the squamosal cannot be represented by the posterior frontal, because the latter is orbital in its relations, while the former is temporal; also that the zygomatic process should not be confounded with the jugal, the one having relations with the squamosal, the other with the maxillary.

The author also states concisely that that bone must be considered the squamosal which, though fixed or movable, is situated in front of the auditory canal, and articulates with the pterygoid and the mandible. In the oviparous vertebrates, the squamosal has commonly been wrongly designated 'the tympanic.' The zygomatic process, whether fixed or free, is always included between the squamosal and the malar. The parts of the temporal are also clearly distinguishable by their teleological relations.

The author furnishes the data for the table (see p. 114) of the synonymy of the temporal bone in the fishes and lower vertebrates. — (*Mem. acad. sc. Toulouse*, iv. 1882, 71.) F. W. T. [129

Nomenclature of the squamosal bone (temporal écailleux) of the Vertebrata pisciformes.

Lavocat.	Cuvier.	Owen.	St. Hilaire.	Agassiz.	Vogt.	Bojanus.	M.-Edwards.	Bakker.	Rosenthal.	Hallman.
Pièce supérieure.	Temporal.	Epitympanic.	Sérial.		Caisse tympanique.		Epitympanique.	Symplecticum primum.	Os carré.	
									[Carus.]	
Pièce inférieure.	Jugal.	Hypotympanic.	Hypocotyléal.	Os carré.		Ptérygoïde interne.	Hypotympanique.	Symplecticum quartum.	Os discoideum.	
Pièce antérieure.	Tympanal.	Pretympanic.	Épicotyléal.	Caisse.			Pretympanique.			Ptérygoïde postérieure.
										[Meckel.]
Pièce postérieure.	Symplectique.	Mesotympanic.	Uro-sérial.				Mesotympanique.	Symplecticum secundum.		Styloïde.

ANTHROPOLOGY.

Domestication of the horse. — M. Cornevin, discussing the earliest evidence of taming the horse, very pertinently sets out with the question, "What is a domestic animal?" and replies, "One that participates in the *domus*, submits itself to the domination of a master, to whom it renders its products or its services, reproduces in captivity, and gives birth to young, which become more and more submissive to control." The idea of domestication comports with that of property in some form. M. Cornevin, for reasons mentioned in his communication, places the time of the event in the bronze age contemporaneous with the bronze bit. The fact seems incontestable that the use of bronze was imported into Europe and Africa from the orient. M. Pietrement, in his work on the origin of the domestic horse, and, before him, M. Pictet, in his *Origines indo-européennes*, have proved that the Aryans, of the central Asiatic plateau, utilized the horse at a time when Europe was in the stone age. In the discussion which followed M. Cornevin's paper, M. Faure remarked, that, while the bronze bit was good proof of the domestication of the horse, the latter may have been tamed long before bronze was known. Indeed, the Gauchos catch the wild horses with a simple lasso. Could not prehistoric man, after catching a horse by means of a lasso, like the Gauchos, have made a simple bridle of raw hide, and have managed the animal thereby? — (*Bull. soc. anthrop. Lyon*, i. 116.) J. W. P. [130

The troglodytes. — M. Alex. Bertrand, conservator of the museum of national antiquities of St. Germaine-en-Laye, delivered an address in December last on the cave-dwellers, now published with copious illustrations in the first part, vol. ii., of the *Revue d'ethnographie* (Jan.–Feb., 1883). The address is in popular language, and gives many valuable particulars, deduced from their remains, of the environment, habits, utensils, and art of the prehistoric inhabitants of Europe. Perhaps the most interesting points are the evidences presented of their domestication of the reindeer, and the parallel drawn between their supposed mode of life and that of the modern hyperboreans. — J. W. P. [131

The Serers of Joal and Portudal. — Dr. A. Corre of the French marine service gives an interesting and illustrated ethnographic sketch of the remarkable people on the west coast of Africa, chiefly near Cape Verd, and mentioned by Brue, towards the end of the seventeenth century, as being strongly distinguished from the surrounding negroes. In many particulars, these people show characteristics similar to those of tribes separated from them by half the circumference of the globe. A short sentence may be literally translated in illustration: "They call the uncle, father; the aunt, mother; the cousins, male and female, brothers and sisters." The writer of the sketch did not appear to understand, or at least to follow up, this evidence of the system of consanguinity and affinity so frequently found in the stage of savagery. — (*Rev. d'ethnographie*, Jan.–Feb., 1883.) J. W. P. [132

Roumanian ethnology. — Trajan conquered Dacia in A.D. 106, colonizing it with subjects drawn from various parts of the empire. When this same country became known to the inhabitants of western Europe, they found there a people speaking a language derived from the Latin, and evidently descended from Roman provincials. With their imperfect knowledge of the intervening centuries, it was but natural, says A. J. Patterson, that they should connect these facts together, and assume that the Wallachs of their own times were the direct descendants of Trajan's colonists, and that they had dwelt uninterruptedly on Dacian soil. As soon, however, as the Rouman language and Rouman institutions were examined in detail, more and more points were discovered which could with difficulty be brought into harmony with that *prima facie* view. Inquirers who were not subject to the disturbing influence of Rouman patriotism came to the conclusion that the present Romance-speaking population of Roumania and Transylvania have migrated thither from the lands south of the Danube since the beginning of the twelfth century. In addition to the ordinary ethnologic evidence, the philological argument has been effectually urged by Paul Hunfalvy. Both in the middle ages and at the present time, a people is found in various parts of the Balkan peninsula whose speech so closely resembles that of the northern Roumans as to prove that they are dialects of one language, and must have been diffused from a common centre. — (*Academy*, May 19.) J. W. P. [133

NOTES AND NEWS.

It was known some months since how Mr. Henri Harrisse had made, as he claimed, a discovery that the Portuguese had as early as 1502 mapped out the eastern seaboard of the present United States from Florida to the neighborhood of 40° north latitude. A few weeks ago Mr. Harrisse laid a copy of the discovered map before the French institute with documentary proof of its date (1502). A more particular statement has reached us in a letter from the Rev. Edward E. Hale, written in Paris, where he had inspected Mr. Harrisse's copy of the map and document which were found in the archives of the Este family in Modena. We must await conclusive particulars, to be published by Mr. Harrisse, before determining if this last be one of the important contributions to the study of early American cartography, which this whilom New-York lawyer has made. Meanwhile it is not at all clear whether the new map is going to contribute any thing further than what we have already known from the old Portuguese chart, which Lelewel gives in his *Géographie du moyen âge*, pl. 43, with a conjectural date between 1501 and 1504. This gives a rude representation of Florida, with its easterly coast trending northerly, and coming abruptly to an end. Lying to the north-east, and in mid-ocean, is a bit of continental shore, indicating the Cortereal discoveries in its latinized name, 'Regalis domus,' with a large island adjacent called 'Terra laboratorum,' or Labrador. The earliest printed map of this region bears a strong resemblance to the Portuguese chart, and would seem to have been based on the same or similar information; and this is the famous Stobnicza map, which was published at Cracow not far from 1512. The 1511 Ptolemy has the Cortereal region, but omits Florida. From two maps in the 1513 Ptolemy a delineation very like the Portuguese chart can be made up; and after this its contours became for some years an established type frequently met with. Another Portuguese chart is well known to students in this field; and that is the one which has been reproduced by Stevens, Kunstmann, Kohl, and others, and is usually placed between 1514 and 1520. If it embodied current knowledge in Portugal, it was certainly not generally known there that the eastern coast united with the Cortereal region; for the ocean is represented as washing uninterruptedly between.

From what Mr. Hale writes. the newly found map would seem to be much the same in character as the 1513 printed Ptolemy maps, thus carrying back their delineation ten or eleven years earlier; and this, we have seen, takes us to the supposed date (1501–1504) of the Lelewel Portuguese chart, which is essentially like the 1513 maps, and seemingly like the Este map: but a sight of Harrisse's discovered chart, in due time to reach us, will give us something more than conjecture on which to base an estimate of its importance.

There is one discovery, however, which we are waiting for, and in time it may come; that is, the evidence, cartographical we hope, rather than documentary, that the Biscayan fisherman knew the Grand Banks and the adjacent coasts long before Columbus. It seems harder not to believe that this was the case than to believe it. The hardy fishermen of the Bay of Biscay had stretched their courses farther and farther to the north in pursuit of the stock-fish or cod, which was the staple food of Catholic Europe for more than a hundred days in the year. They had gone to Iceland, and, by easy gradation, to the Greenland seas; and we must remember that on this very Portuguese chart of 1501–1504, and in the Ptolemy, preceding the time of Columbus, Greenland was but a prolongation of north-western Europe. Accordingly, following their game, the fishermen could easily have cruised still farther along the Labrador coast, and to the neighborhood of Newfoundland, without in the least supposing they had found a new world, but rather a hitherto unvisited region of the old world. So, on their return, their sailor's yarns would raise no suspicion of a new quarter of the globe, such as Europe was startled at when Columbus returned from his purposed quest. It was not the fishermen's report, accordingly, that could have incited Cabot; but, when news reached England of the discovery of the Spaniards, it can easily be conceived how these sailor's yarns may have been interpreted in the belief that the land found by Columbus must, by the analogy of continents, have stretched to the north, and could be found by sailing west from England. Further, so far as Columbus' views were shared, that he had reached the coast of Asia, the reports of Marco Polo and the rest showed that the Asian coast must lie also in that very direction. Now, when Cabot reached the land, and found the natives calling the stock-fish or cod, *baccalaos*, where did they get the very term which Biscayan fishermen had applied to the same fish for centuries? This has always been a puzzle. It seems to us that it will yet be discovered that Cabot had only reached by a southern passage the region which the Biscayans had long been sailing to by the northern. The archives of Europe, we are confident, will yet reveal the proof. Only last summer the Rev. Mr. Hale, searching the archives at Madrid, found a sketch by Cortes of the Gulf of California, made six years before the earliest that had previously been known; and it disclosed the extent of Cortes' own examination of the Pacific coast in advance of his captains. The archives of the old world have by no means yet yielded all that they may.

— The funeral of the late Mr. William Spottiswoode took place at noon July 5 in Westminster Abbey, and was attended by many distinguished men from the various scientific and other societies with which the deceased was connected. There was also a large attendance of the general public. The pall-bearers were Marquis of Salisbury, Oxford university; Lord Granville, London university; Sir W. Siemens, British association; Sir F. Leighton, Royal academy; Sir J. Lubbock, Linnaean society; Sir Bartle Frere, Royal Asiatic society; Sir W. Armstrong, Institute of civil engineers; Dr. Evans, Royal society; Chancellor of the exchequer, H. M. government; Duke of Northumberland, Royal institution; Master of the stationers' company, the company; Lord Aberdare, Royal geographical society; G. Busk, Esq., Royal astronomical society; Professor Flower, Zoölogical society; Mr. Shinn, Mr. Carey, Mr. Hunt, Mr. Millwood, Mr. White, Mr. Wilson, representing departments in the Queen's printing-office.

The *Athenaeum* says of Mr. Spottiswoode: "Mr. W. Spottiswoode's illness had from the first caused serious alarm; still it was hoped that he would triumph over typhoid-fever, though complicated by congestion of the lungs. His strength had, however, been shaken by the severe accident he met with some months ago, and there is little doubt that his indefatigable attention to duties of various sorts had overtasked even his vigorous constitution. He combined with the studies of a physicist and a mathematician the supervision of a great mercantile concern. To accomplish all this; to make elaborate and delicate experiments, contribute a succession of papers to the *Transactions* of the Royal society and *The Philosophical magazine;* to mix frequently in general society; to preside over the chief of our scientific bodies, and manage a large business, — was possible only to a man who would map out the work of every day, and never waste a minute of his time. And this was the case with Mr. Spottiswoode. His was eminently an organizing brain, gifted with great clearness, complete mastery of detail, unfailing punctuality, and power at once to seize the essence of any matter brought under his notice. Personally he was most kind and generous, eminently tolerant of differences of opinion, and courteous to all with whom he came in contact."

— On Thursday night, July 12, 1883, the newer of the buildings of the Indiana university was struck by lightning and thoroughly destroyed. The building was a four-story brick of Gothic design. Upon the first floor were the collections of geology, mineralogy, and archeology, and the chemical laboratory; on the second floor were the libraries and the physical laboratory; while the third contained the valuable zoölogical collections of the university, and the museum of comparative anatomy. The loss as reported is as follows: museum, $75,000; library, $36,000; laboratory, $10,000; building, $45,000; total, $166,000; upon which there was a total insurance of $27,454.54.

The entire Owen collection of 85,000 specimens of geology and mineralogy was destroyed. This collection contained many types of species described by David Dale Owen and others. The geological collection also contained many noted specimens from Europe and America, among the more celebrated of which were the large Würtemberg Ichthyosaurus, and a Megalonyx from Henderson, Ky. The latter has fortunately been described and figured by Professor Cope for the forthcoming report of the Indiana geological survey. A fine set of Ward's casts was also destroyed, but can readily be replaced.

Professor Van Nuys' chemical laboratory, containing a number of fine imported pieces of chemical apparatus; Professor Wylie's physical laboratory, including a number of the owner's ingenious mechanisms, and the entire ichthyological collections of Professors Jordan and Gilbert, — representing years of patient work, and probably the finest private collection of fishes in the United States, — were also destroyed, together with valuable collections belonging to the U. S. national museum, Yale college, Cornell university, and other institutions.

The Brookville society of natural history, of Brookville, Ind., has been the first to offer aid to the institution: they have placed their entire collection of duplicates at the service of the trustees, from which several thousand specimens will be received as soon as arrangements can be made to accommodate them. It is understood that the trustees will proceed at once to replace the building which was destroyed; and they should erect a substantial fire-proof building in which to keep what valuable material they may hereafter acquire.

— The circular of the local committee of the American association announces reduced rates on very many railways and at the hotels of Minneapolis. The latter, however, are crowded at this season; and members are recommended to resort to the suburban hotels on Lake Minnetonka and Lake Calhoun, about twelve miles from the city, to and from many of which the railways will carry members free, the time being about half an hour. Many members will be entertained by the citizens of Minneapolis; and a sub-committee will endeavor to find entertainment for all who will notify its chairman, Hon. A. C. Rand, early, of their intention to be present.

The usual favors will be granted by the telegraph companies. Badges, a daily lunch, and low-priced carriages will be furnished, together with a descriptive and illustrated guide to the city of Minneapolis, now in preparation. Express packages containing apparatus, specimens, maps, books, drawings, or other articles designed for use in the meetings, will be forwarded by the American express company, and delivered free of charge at the University of Minnesota. Such parcels should be addressed in care of Prof. J. A. Dodge, to whom, also, all correspondence relating to the same should be sent. After Aug. 12, letters may be addressed to members at Minneapolis, in care of the association, and they will be delivered from the office of the local committee at the university.

An excursion will be made to Minnetonka, and return, on Saturday afternoon, when a lawn picnic will be served at the Lake Park Hotel. If a party of a hundred and fifty or more desire to make an excursion to Winnipeg, and return, at one-half of regular fare, the St. Paul, Minneapolis, and Manitoba railway will send a special train for their accommodation. No definite arrangements have yet been made for other excursions.

The retiring address of President J. W. Dawson will be given at the Westminster church, on Nicollet avenue, on Wednesday evening. After the address a reception will be held by the local committee at the Nicollet House.

The meeting will probably be one of special interest to glacial geologists, numerous papers concerning the terminal moraine and other glacial phenomena being expected.

— The annual meeting of the Society for the promotion of agricultural science will be held in Minneapolis on Aug. 13 and 14, in the Agricultural college building, of the State university.

— A special public meeting of the Cambridge entomological club will be held in Minneapolis, at the chapel of the university, at two P.M. on Tuesday, Aug. 14, to which all persons interested in entomology are invited.

— The annual meeting of the American forestry congress will be held at St. Paul, Minn., commencing on Wednesday, Aug. 8, 1883. The local committee has in charge the arrangement of railroad facilities, etc., announcement of which will be sent to all members in due time, and to all those who express their desire to attend the meeting. Papers to be read at the meeting, or abstracts of the same, should be sent in to the corresponding secretary two weeks before meeting, according to the by-laws of the congress.

— A geographical and ethnological exhibition will be held in Nancy from Aug. 20 to Sept. 20.

— The French association for the advancement of sciences meet at Rouen, Aug. 16–23.

— The sixth congress of the French geographical societies will meet under the presidency of M. de Lesseps at Douai on the 26th of August, and remain five days in session. A geographical exposition will form a feature of the meeting. The seventh congress will meet at Rouen in 1884, and the eighth at Oran in 1885.

— The seventh congress of the Russian scientific association will be held in Odessa from Aug. 30 to Sept. 9.

— The sixth annual meeting of the American society of microscopists will be held in Chicago, beginning Tuesday, Aug. 7, 1883, and continuing four days. Ample preparations are making by the committee of the State microscopical society of Illinois, and the Chicago academy of sciences; and the attendance of members is expected to be larger than ever before. First-class hotel accommodations at reduced special rates have been secured, and choice arrangements made for the comfort and convenience of the meeting. Titles of papers may be sent to the secretary, Prof. D. S. Kellicott, Ph.D., 119 14th St., Buffalo, N.Y. Full provision will be made for illustration, by projection apparatus, of any article when the authors may so desire. A special hour will be allotted each day to the exhibition of objects and apparatus referred to or described in communications read before the society; an evening will also be set apart for the presentation of methods of work, including staining, section-cutting, mounting, microphotography, etc. A general microscopical *soirée* will be held on another evening, and members are requested to bring instruments and slides with them. The exhibition of instruments and accessories by makers and dealers promises to be unusually fine.

The officers of the society are Albert McCalla of Fairfield, Io., president; E. H. Griffith of Fairport, N.Y., and George C. Taylor of Thibodeaux, La., vice-presidents; D. S. Kellicott of Buffalo, N.Y., secretary; and George E. Fell of Buffalo, N.Y., treasurer.

— The Société académique of Brest held an exhibition of matters relating to geography, June 3–17. An especial object was to bring to notice the rich ethnological material which has accumulated in this city during many years. The halls devoted to Japan, China, Cochin-China, and West Africa, presented much of interest.

— In the *Philosophical transactions* for 1817 (p. 325), Sir William Herschel says, that, "beside the 683 star-gauges published in the *Philosophical transactions* for 1785 (p. 221), above 400 more have been taken in various parts of the heavens."

These four hundred unpublished gauges have lately been extracted from the original observing-books preserved at the Herschel family residence at Collingwood, through the kindness of Sir William Herschel, the present baronet, and of his brother, Major John Herschel; and the manuscript has been presented to Professor Holden, director of the Washburn observatory.

The original records are in the handwriting of Miss Caroline Herschel, and by her faithful care every detail necessary to their accurate deduction is preserved. It will be observed that only two-thirds of the star-gauges of Herschel have heretofore been known. The new acquisition will be welcomed by those interested in this class of observations. They are a new gift from an inexhaustible mine.

— The bureau of education has just published a circular of information, containing the results of an inquiry into the effects of co-educating the sexes in three hundred and forty cities and large towns of the Union. Of these, three hundred and twenty-one practise co-education throughout the public-school course, seventeen co-educate for part of the course, and two separate the sexes entirely. A careful analysis of the reasons adduced for co-education enables the editor to formulate them as follows: co-education of the sexes is preferred where practised, because it is, 1°, *natural*, following the usual structure of the family and of society; 2°, *customary*, or in harmony with the habits and sentiments of every-day life and law; 3°, *impartial*, affording to both sexes equal opportunities for culture; 4°, *economical*, using school-funds to the best advantage; 5°, *convenient* both to superintendent and teachers in assigning, grading, instruction, and discipline; and, 6°, *beneficial* to the minds, morals, habits, and development of the pupils. The pamphlet concludes by observing that "both the general instruction of girls, and the common employment of women as public-school teachers, depend, to a very great degree, on the prevalence of co-education, and that a general discontinuance of it would entail either much increased expense for additional buildings and teachers, or a withdrawal of educational privileges from the future women and mothers of the nation."

— Mr. Charles B. Dyer, a well-known collector of Cincinnati fossils, died at his home on Wednesday, July 11, after a painful illness of over three months' duration. He was for many years engaged in amassing one of the finest collections of local paleontology in the country, which now reposes in the Agassiz museum in Cambridge. His rarest fossils were collected by himself, and his industry in the pursuit of new and fine specimens was untiring. In connection with Mr. S. A. Miller, Mr. Dyer issued a few years ago, at his own expense, a pamphlet with two plates, containing descriptions of new forms from his collection, entitled 'Contributions to paleontology.' Thirty years ago Mr. Dyer retired from business with a moderate fortune, and devoted all his time to collecting. He was an eccentric man, with strong feelings, but a fast friend and a pleasant companion. He was in the seventy-eighth year of his age, and had lived in Cincinnati for over fifty-five years. His name is attached to one of the commonest crinoids of the Cincinnati rocks, Glyptocrinus Dyeri, and to several very rare and beautiful forms discovered by him.

— The Imperial geographical society of St. Petersburg has awarded its great gold medal to H. W. Abich for his researches into the geology of the Caucasus. The Lütké medal was received by W. K. Döllen of the Pulkova observatory for improvements in astronomical instruments; Vitkoffski, Barsoff, and Krasnoperoff have received medals for ethnographic and statistical works; Oshanin, for travels in Turkestan, etc. Silver medals were awarded to Brunoff for meteorological researches, and to Lessar, Schultz, Gladisheff, Kiseleff, Rodionoff, and Slovtsoff for surveys and journeys, chiefly on the Asiatic frontier of Russia.

— The observatory at Moscow was among the establishments of the northern hemisphere which co-operated with Mr. David Gill, Her majesty's astronomer at Cape Town, in securing observations of the small planet Victoria, at its late opposition, for a new determination of the solar parallax. The ninth volume (livraison i.) of the *Annales* of this institution contains the results of these observations, together with several papers by its director, Dr. Bredichin, relating to comets and allied subjects.

RECENT BOOKS AND PAMPHLETS.

**** Continuations and brief papers extracted from serial literature without repagination are not included in this list. Exceptions are made for annual reports of American institutions, newly established periodicals, and memoirs of considerable extent.*

Hospitalier, E. Formulaire pratique de l'électricitien. année i. 1883. Paris, 1883. 280 p., illustr. 12°.

Huxley, T. H. Il gambero. Introduzione allo studio della zoologia. Milano, 1883. 352 p. 8°.

Johnston's Botanical atlas; with explanatory text. 2 vols. (i. Phanerogams; ii. Cryptogams). London, 1883. 52 pl. 4°.

Jónás, J. Studien und vorschläge auf dem gebiete des lebensversicherungs-geschäftes. Berlin, 1883. 83 p. 8°.

Kloeber, C. Der pilzsammler. Genaue beschreibung der in Deutschland und den angrenzenden ländern wachsenden speiseschwämme nebst zubereitung für die küche, sowie kulturanweisung der champignonzucht. Quedlinburg, 1883. illustr. 8°.

Kobelt, W. Iconographie der schalentragenden europäischen meeresconchylien. heft 1. Kassel, *Fischer*, 1883. 16 p., 4 lith. 4°.

Krok, O. B., och **S. Almqvist**. Svensk flora för skolor. i. Phanerogamer. Stockholm, 1883 26+198 p. 8°.

Le Monnier, G. Dix leçons de botanique. Paris, 1883. 124 fig. 12°.

Lepsius, R. Das Mainzer becken, geologischer beschreibung. Darmst, 1883. illustr. 4°.

Luhmann, E. Die fabrikation der dachpappe und der anstrichmasse für pappdächer in verbindung mit der theerdestillation nebst anfertigung aller arten von pappbedachungen und asphaltirungen. Wien, 1883. 256 p., illustr. 8°.

Magaud, L. Les oiseaux de la France. Première monographie: corvidés. Histoire naturelle et particulière des passereaux déodactyles cultrirostres observés en France. Paris, 1883. 4°.

Medical era. vol. i., no. 1. Chicago, *Gross & Delbridge*, July, 1883. 8+32 p. 8°. *m.*

Mina-Palumbo, F. Monografia botanica ed agraria sulla cultivazione dei pistacchi in Sicilia. Palermo, *Lauriel*, 1883. 272 p., 28 pl. 8°.

Nazzani, I. Trattato d'idraulica pratica. vol. i. Milano, *Hoepli*, 1883. 646 p. 8°.

Patouillard, N. Tabulae analyticae Fungorum. Descriptions et analyses microscopiques des champignons nouveaux, rares ou critiques. cent. i. Poligny, 1883. illustr. 8°.

Pattison, M. M. Chemists. London, 1883. (Heroes of science.) illustr. roy. 8°.

Petermann, A. Recherches de chimie et de physiologie appliquées à l'agriculture. Analyses de matières fertilisantes et alimentaires. 1872–82. Bruxelles, 1883. 448 p. 8°.

Peters, P. Darstellung elliptischer functionen durch flächen. Königsberg, 1883. 32 p. 4°.

Pucci, E. Fondamenti di geodosia. vol. i. Milano, *Hoepli*, 1883. 403 p. 8°.

Rovelli, C. La teoria delle funzione potenziale di Green applicata allo studio dei fenomeni della gravitazione universale. Como, *Franchi*, 1883. 96 p. 8°.

Saint-Lager. Des origines des sciences naturelles. Paris, 1883. 134 p. 8°.

Sauvage, H. E. La grande pêche (poissons). Paris, 1883. illustr. 8°.

Slack, J. H. Practical trout-culture. New York, 1883. illustr. 8°.

Strasser, H. Zur kenntniss der funktionellen anpassung der quergestreiften muskeln. Stuttgart, 1883. 115 p. 8°.

Targioni-Tozzetti, A. Ortotteri agrari. Firenze, 1882. illustr. 8°.

Toula, F. Geologische karte von Oesterreich-Ungarn nebst Bosnien und Herzegovina. Wien, 1882. f°.

Vallot, J. Études sur la flore du Sénégal. fasc. i. Paris, 1883. 80 p., pl. 8°. [To contain 6-8 fasc.]

Vélain, Ch. Cours élémentaire de géologie stratigraphique. Paris, 1883. 316 p., illustr. 12°.

—— Excursion géologique dans le Morvan. Paris, 1883. 129 p., illustr. 4°.

Violle, J. Cours de physique. tome i. Physique moléculaire, partie 1. Paris, 1883. 511 p., 259 fig. 8°.

Wernicke, A. Grundzüge der elementar-mechanik. Braunschweig, 1883. 448 p., illustr. 8°.

Zoltz, A. de. Principii della eguaglianza di poliedri e di poligoni sferici. Milano, *Brida*, 1883. 48 p. 8°.

SCIENCE.

FRIDAY, AUGUST 3, 1883.

THE U. S. NATIONAL MUSEUM.

II.

In a former number we reviewed some of the important principles of general classification suggested by Mr. Goode's plan of the National museum. We resume the topic to discuss some of the salient points in the minor groupings of the same scheme.

Section iii., 'natural resources,' i.e., 'force and matter,' appears to be out of place. Certainly these are primary subjects; and we cannot, as a merely practical matter, understand why the study of physics and chemistry is placed after that of the earth, which is to be treated of earlier under the separate heads of 'cosmology,' 'geology,' 'physiography,' etc., in section ii. Imagine a person trying to learn something of the relations of force and matter to the history of the development of the earth and its topography as it now appears, and having in view the applications of these studies to the explanation of some of man's migrations or racial differences, or to any other anthropological problem which might reach back to primary connections. Is it supposable that his inquiries would be facilitated by placing the collection in such relations to each other as completely to cover up and invert their natural relations and logical order? Or is it probable that the mind of the visitor would be more enlightened by getting his information about the relations of the elements after he had passed through celestial and terrestrial physics and chemistry, and all the applications of these to the history of the development of the earth?

We can readily picture to ourselves the confusion which might be generated in his mind, and the discovery he might make of the necessity of reviewing all he had passed over before; but we fail in attempts to imagine the advantages of this inversion. We cannot, therefore, understand the considerations which induced Mr. Goode to adopt this method of arranging the sections, nor why he did not place natural resources first, and man last, in his natural history division; for that is what the first three sections really constitute when taken together. They would then have stood in approximately natural, and certainly respectably logical, relations to each other.

We should then have had in section i., physics, chemistry, and all the mineralogical, botanical, and zoölogical collections as introductions to the study of section ii., where the principles of science learned in passing them in review would be found of essential assistance in understanding the earth, with all the topics of cosmology, geology, etc., whether presented, as Mr. Goode proposes, solely as man's abode, or in its more natural relation to the universe as a planetary body. The last seems to us the preferable because more natural mode of presentation; and the author shows this by bringing in cosmology. This, if at all effective, must show that the earth is a planet primarily uninhabitable by man, and evolved without reference to his existence, conducted in its career by cosmic forces uninfluenced by his presence, and, in all likelihood, destined to become unfit, in course of time, for his existence.

After the earth as man's abode had been passed through by the visitor, we could readily conceive of his being all the better prepared for the understanding of section iii., 'the natural history of man and his adjuncts of all kinds.'

Passing over section iv. ('the exploitative industries') and section v. ('the elaborative industries'), which together constitute what appears to be a second grand division of the museum representing the purely industrial side, we come to section vi. In this section are included foods, and drinks in their final stages of preparation for the use of man, narcotics, dress, buildings, furniture, heating and illumination, medicine, hygiene, transportation. All of these are supposed to have a more direct relation to the physical condition of mankind, either from their nature, or in the peculiar stages of their manufacture which makes them admissible to the cases of this section.

Section vii., 'social relations of mankind (sociology and its accessories),' is to be an exposition of the appliances and methods made use of by man in his social relations, communication of ideas and their record, trade and commerce, societies and federations, government and law, war, ceremonies.

Section viii., 'intellectual occupations of mankind (art, science, and philosophy),' is to show the existing intellectual and moral condition of man, and the most perfect results of human achievement in every direction of activity. Its topics are to be games and amusements, music, the drama, the arts, literature, folk-lore, science, philosophy, education, and climaxes of human achievement.

The sixth to the eighth sections contain the special topics which can be used to illustrate the results of the intellectual progress of man more completely and directly, perhaps, than the industries, in sections iv. and v.; and these are accordingly placed in a succession leading naturally to their culmination in the topic which terminates section viii., and is at the same time the sixty-fourth and last of all of the topics. This terminal topic is to be an exposition of the most remarkable achievements of man. The separation of this from the final topic of section i. ('man in his individual manifestations, representative men, biography') shows, that, though Mr. Goode has kept in view the key-note of man's progress in civilization, the development of the individual, he has nevertheless either failed in seeing, or considered of subordinate importance, the racial peculiarities and advantages of which the representative man is necessarily only the concentrated or focalized expression.

In fact, this want of what we might call psychological insight is apparent everywhere; and throughout the scheme the race is subordinated to the notion that man should be presented and considered as a whole, whether in the development of the topics separately, or the purely comparative arrangement of the sixty-four topics themselves as assembled in the different sections of the museum. In section i. man is treated of 'psychologically as a unit;' and it is only in the second topic of this section, where the natural relations of men force the treatment to stand upon a racial basis, that we find this policy even apparently abandoned. We say apparently; because, as we understand it, the effort here will be not to show the historical or physical development of the races, so much as to contrast them side by side and exhibit the characteristics of each race.

In all its parts, the arrangement is based in each topic upon a comparison of the work of different races; and the objects used for these purposes must be withdrawn from their natural associations in other collections, and their significance in the history, physical and psychological, of any particular race, be sacrificed.

This is the method of comparative anatomy, and has certain obvious advantages for the study of anatomy if it is confined in application within the well-defined limits of any one type of plants or animals; but it is liable to lead to serious errors when carried beyond these limits. The dismembered organs or parts, though similar, are, when found in distinct types, unquestionably often distinct in origin. The comparative method necessarily cuts across the natural order of things in their relations to time and to the successive stages of their development: and this is an obvious defect, which, when applied to anthropological collections, is destructive of all natural conceptions as to the way in which modifications and changes really arise or flow out of pre-existing localized or racial conditions.

Anthropology as a science is essentially concerned in tracing the history of different races of men: it clings to the race as the safest basis of classification at present existing, and it is the test by which all general conclusions with regard to the nature of man and the evolution of civilization are judged. A museum of anthropology departs widely from this basis and true scientific conservatism when it assumes the task of harmonizing the psychology of all the races of men, especially in the present almost unexplored condition of this field in savage races, and when it declares that it can present a true picture of the existing condition of man by the method of general comparison of things whose connections, as they stand side by side, are obviously unnatural.

The presentation of the results of achievement in all directions, as attained by each race or natural association of races, could not have been open to such serious objections, would have been far more effectual, and more in accordance with the principles of modern classification and the practice of museums of anthropology. It would, at any rate, have retained the collections in what are known to be their natural relations; such a presentation could not have failed, therefore, to meet the wants of the future and the demands of the present in a more effectual way than by any artificial classification, whatever its convenience.

We do not think that the industrial side would have suffered from this policy, but, on the contrary, we think its subjects would have greatly gained in interest from being shown as developed by the different races; nor do we believe that such a plan would have demanded more room than the present plan, required any more duplicate collections for its proper illustration, or yet have greatly increased the difficulties of the classification of topics which Mr. Goode has so ably handled in his scheme.

The comparative method could then, if deemed necessary, have been resorted to as a crowning effort to show, side by side in a single collection, the ultimate achievements and results attained by each race, how far it had been able to advance in civilization, and what influence, if any, its finest work had had upon the existing conditions of that civilization. Such a summary certainly could be so limited by judicious selection as to be brought within the mental grasp of the intelligent and diligent student; whereas a definite conception of Mr. Goode's sixty-four topics presupposes mental powers of a titanic order. In fact, the graphic picture of civilization which they will present will, from their number and mode of arrangement, be necessarily heterogeneous, — an improvement, no doubt, on general notions in being composed of objects instead of individualized mental conceptions, but certainly not capable of giving the harmonious effect which the author aims at producing.

The National museum is, however, to be not only the representative educational museum of this country, but is also to be combined with departments of research. We have, therefore, to consider the probable influence of the museum of education and its collections upon the departments of research, bequeathed to its care by the Smithsonian, as well as those likely to come under its influence in the future. These last collections might, perhaps, be safely left to themselves; but it must be remembered, that, though at present secure, they will eventually obey the law of attraction, and their curators must begin immediately to take an active interest in the collections which are to represent their achievements before the country at large, and the relations of these departments to the prospects of investigators.

At present the departments of research and those of education are not only under one head, but the subordinate offices are also united in the same persons. Under these circumstances, we view with apprehension certain tendencies, which are evident in the pamphlet before us, and especially the prominence given to the industrial sections. Their present mode of arrangement and ideals do not definitively shut out all possibility of co-operation with business; on the contrary, if we understand certain passages in Mr. Goode's pamphlet, this co-operation is invited, and some firms are already providing the cases with collections of industrial products. We know that science is not the weakest now in the National museum, and our fears will probably highly amuse the officers of the industrial sections; but nevertheless, we cannot see what is to prevent enterprising firms from presently finding out the value of these departments as advertising mediums, and being aggressively if not successfully generous in supplying their wants with expensive gifts, accompanied by their business-cards. The fertility of the imagination in the construction of wedges may certainly be counted upon as quite equal to the opening of any cracks which may present themselves; and we think it would have been far more prudent to recognize and provide for these dangers, however remote they might be considered.

We are, of course, conscious that the joining of hands between science and the industries is the general drift of the tendencies of the day, especially in this country. That this will elevate the industries, we have no doubt; but that it will also elevate the ideals of science, we do not believe. How will the future director, however scientific, avoid the necessity of becoming, before the government and the country, the representative of great commercial and industrial questions and interests, and be in danger of having his interests and his thoughts drawn into the vortex of such affairs, to the exclusion and neglect of the purely scientific aims and objects of the museum? We do not claim that this will be sure to be the case, but simply that we do not see how he can avoid the natural results of his position at the head of the great industrial museum of the country.

Mr. Goode's pamphlet also contains other matters, which, when viewed in the light given by the past history of other museums, show the neglect of essential precautions. There is, for example, no provision for limiting the accumulations of specimens. On the contrary, overpowered by the wants of his world-embracing scheme, he appeals to public-spirited citizens to come forward and deposit their valuable and extensive private collections; and it is especially recommended that the officers, by a wise forethought, should encourage this propensity to the utmost.

Private collections have been made for the most heterogeneous purposes; and it is well known that their possessors usually demand, in return for their generosity in giving them, that they shall be kept together, or have a goodly proportion of exhibition space allotted to them. Such unqualified appeals, and the neglect of all other precautions [1] against the unlimited acquisition of materials, are entirely at variance with the selective policy previously announced, and a complete surrender of the principles which should govern a museum starting with a new ideal, and bent upon avoiding the errors of policy and the unnecessary burdens which had been previously and truthfully described by Mr. Goode as the greatest obstacles in the path of the older museums.

It does not require a prophetic eye to see in the near future, that assisted by the Fish-commission, the Geological survey, and other departments of the government, the business energy and liberality of the American citizen, the pride, energy, and influence of the present staff of museum, uncontrolled by any prudential considerations, and stimulated by the universal field they are required to cover, will heap up materials not only faster than they can be handled, but in such masses that they will become, as in older museums, serious obstacles to the progress of the museum of education itself, and be still more serious in their effects upon the museum of research. The resources of the National museum, however great they may be, will inevitably find themselves, sooner or later, blocked by these accumulations; and their care will occupy the time of the officers in an increasing ratio. Luckily for science, men in such positions have frequently found themselves unable to resist the suggestive seductions of research, and allowed collections to suffer while they studied; but many, too conscientious to do this, have been sacrificed to the mere preservation of materials, whose labors would have repaid the daily wages of many more lower-class laborers to any civilized government. Large accumulations, however, not only directly discourage the investigator by

[1] That we are not misrepresenting the spirit of the museum by this remark may be learned in Mr. Goode's own words: "The classification proposed should provide a place for every object in existence which it is possible to describe, or which may be designated by a name. When the object itself cannot be obtained, its place should be supplied by a model, picture, or diagram."

wasting his time, but their necessary preservation strikes at a still more vital point in using up funds which could otherwise be employed for the publication of the results of researches. They also equally interfere with the purchase of delicate instruments, the employment of labor to directly assist in carrying out the purposes of research, prevent the purchase of such specimens or collections as may be essential, and cut off opportunities for travel and study in other museums or parts of the world.

We think, therefore, that, while the National museum may open some paths to the investigator, it will neither directly do the very best work in this direction, nor give us any grounds for believing that it will introduce a new era of prosperity for abstract investigation. It will add one more to the useful scientific institutions of its kind, it will undoubtedly contribute to the progress of science by increasing the opportunities for employment and by the example of its officers; but it will not do much for them or for us in the way of an exalted ideal.

If the museum of education had been limited by a wise policy of selection in its accumulations of materials, and placed under a distinct staff, we could have made no such objections; then the practical objects of its existence would not have suffered, as they now surely will, from the psychological tendencies of the investigating curators; nor, on the other hand, would the investigators themselves have been distracted by having a double purpose in all that they were doing, and frequently obliged to sacrifice one or the other. We do not wish to imply that the museums should not be under one general head, and have all the benefits of mutual association, but simply insist that the ideals are quite distinct, and the officers should realize this by being under different regulations, and under a different government, in each of the two museums. The investigator cannot avoid placing on exhibition the record of his own and others' work; and he will find a thousand good reasons for crowding the cases with fine collections, because they are fine, and because they are important in research, or unique, or remarkable; and the educational idea will be subordinate or completely lost in such parts of the museum, so far as the average student is concerned.

The cost of the museum will be enormous; but if its lessons can be easily mastered by the average student, and in this case the student is the average congressman, he will not begrudge the funds which are necessary for its support. It must be remembered that these are keen men, quick to see the advantages of such lessons as the museum can teach them; especially if, like the library, it can make itself really useful to them, and keep up with the times by illustrating the new results of discovery and research in all departments of learning in an explanatory and popular way. We imagine that they will not be slow in calling upon the officers of the museum whenever they have need of their services, and that they will be rather disgusted if any of the requirements of research interfere with their desire for information.

While we wish the greatest success to the National museum and its energetic and deservedly popular director, and have the highest respect and friendliest feeling towards their undertaking, and a faith that they will finally work out a better result than is promised, we think that neither this faith nor their great scientific achievements, of which we are justly proud, nor the liberality of the government, can entirely make up for the absence of the public recognition of a more purely scientific ideal in *our* National museum.

KINETIC CONSIDERATIONS AS TO THE NATURE OF THE ATOMIC MOTIONS WHICH PROBABLY ORIGINATE RADIATIONS.[1] — II.

Having now sufficiently cleared the field of inquiry by this preliminary discussion, let us consider the proposed hypothesis somewhat more closely, both as to what it is precisely, and as to how far it is in accordance with the phenomena. The whole outcome of Lockyer's investigations, to which we have referred, leads to the conclusion that atoms of the chemical elements are complex bodies, all of which

[1] Concluded from No. 24. See also *Proc. Ohio mech. inst.*, II. 89.

are formed of ultimate atoms of the same kind; so that, on this hypothesis, there is but one kind of substance from which all others are compounded. Chemical atoms might be compared to a chime of bells all cast from the same material, but each having its own special series of harmonic vibrations.

A necessary result flowing from this hypothesis would be, that the atomic weights should all be exact multiples of some fraction of the atomic weight of hydrogen, which would include Prout's hypothesis as a particular case. The experimental data are, perhaps, not yet sufficiently precise to enable us to obtain a trustworthy result as to the probability of the truth of Prout's hypothesis; yet Clarke's[1] results as to the atomic weights seem to show that the hypothesis has a high degree of probability.

If the chemical atoms of all bodies are assumed to be formed of ultimate atoms, which are in all respects equal and alike, this hypothesis furnishes a basis for investigation at once definite and simple, some of whose consequences we shall now endeavor to show to be in accordance with experimental facts.

We wish, in the first place, to show that this hypothesis will make the temperature of a gas proportional to its mean kinetic energy. A chemical atom may be assumed to be a perfectly elastic body, as its deformation is assumed to be extremely small. But according to the mathematical theory of elastic impact,[2] "when two such bodies come into collision, sometimes with greater and sometimes with less mutual velocity, but with other circumstances similar, the velocities of all particles of either body at corresponding times of the impacts will always be in the same proportion;" from which it is clear, that in a mixture of two kinds of gas, as hydrogen and oxygen for example, when the mean velocity of the molecules is so increased that the vibration of the ultimate atoms of the hydrogen is increased a certain per cent, then that of the ultimate atoms of the oxygen is increased by the same per cent. But the circumstances of the encounters and the forces acting between the ulitmate molecules determine what fraction the mean kinetic energy of vibration of the ultimate atoms shall be of that of the molecules whose encounters cause these vibrations. Since the circumstances attending the encounters are dependent simply upon the forces acting between the ultimate atoms assumed to be in all respects equal, the energy of their vibration will be the same in an atom of hydrogen as it is in an atom of oxygen; for each degree of freedom of every ultimate atom of either element is similarly circumstanced, both as regards forces between itself and other ultimate atoms of the same chemical atom, and also as regards the impacts of other molecules. The proposition of the kinetic theory which makes the energy of each degree of freedom the same, which has been erroneously applied to the degrees of freedom of molecules, can therefore be correctly applied to the ultimate atoms.

But it might not, at first glance, be apparent whether these vibrations are caused by, and are proportional to, the mean progressive energy of the molecules, or to their rotary energy combined with it. But it is not difficult to show that the vibrations of the chemical atoms with respect to each other are proportional to the mean progressive energy alone, and then to show the same for the ultimate atoms. Although, in the paper upon the vibratory motions of atoms within the molecule, we have for mathematical purposes considered the centrifugal force as causing vibrations of atoms with respect to each other, yet in fact the vibrations so caused are vanishing quantities, compared with those caused by the component of the impulsive force acting during an encounter along the line joining the atoms of a molecule. The magnitude of such a vibration, other things being equal, depends upon the suddenness of the impulse; and the suddenness of the force called into play during a change of rotary velocity, by deviation from motion in a tangent to motion in a circle, can bear no comparison to the suddenness of a direct impulse along the radius of the circle. Hence the direct impulse due to the progressive motion need alone be considered.

It thus appears that the energy of vibration of chemical atoms with respect to each other in a simple gas is proportional to its mean progressive energy. The same is true of the vibrations, with respect to each other, of the ultimate atoms which form a chemical atom, and for the same reasons; for the forces which act upon the ultimate atoms are the impulses due to the encounters of other molecules, and those due to the remaining chemical atoms of the same molecule. The energy of the latter of these motions is proportional to the former, as has just been shown; hence their sum is so also: therefore the energy exerted to deform a chemical molecule, and set it in vibration, is proportional to the mean progressive energy.

[1] Constants of nature, part v. A recalculation of the atomic weights. Washington, 1882.
[2] Thomson and Tait's Natural philosophy, 1867, art. 302.

But it is to be noticed that the impulses due to the vibrations of the chemical atoms within a molecule are vastly more frequent than the molecular impulses; and it appears probable that the vibrations of the chemical atoms set up during an encounter will rapidly decay, even in case they do not themselves directly originate radiations. The vibratory energy of this kind may then be changed almost instantly into that of vibration of the ultimate atoms.

According to the hypothesis which we are now considering, the temperature of the body and the intensity of the radiation depend solely on the vibratory energy of the ultimate atoms; but, since these ultimate atoms are assumed to be in all respects equal, they vibrate under the action of the same forces, and have the same degrees of freedom and constraint within the chemical atoms of one element as they do within those of a different element. Hence it appears, that if the ultimate atoms of two different gases have the same vibratory energy (i.e., cause vibrations of the same intensity), so that the flow of radiant energy is the same from all the ultimate atoms of each gas, then there will be no disturbance of this equilibrium when these gases are mixed; in which case the distribution of energy is effected by molecular encounters, which distribute equal mean amounts of energy to each molecule, instead of by radiations, which distribute equal mean amounts of energy to each ultimate atom.

In attempting to account for the high specific heat of liquids, I have elsewhere given reasons for supposing that it is due to a certain per cent of dissociation, which increases with the temperature. It appears probable, that, although some small amount of dissociation may exist in gases also, there is not so large a per cent as in the liquid state, nor does the per cent necessarily increase with the temperature; for by reason of the free progressive motion in a gas, which does not exist in a liquid, any dissociated atoms have a much better opportunity to recombine; and, as the velocities (especially those of free atoms) increase with the temperature, these opportunities increase, as well as the number of dissociations occurring in a unit of time; so that, at a high temperature, an atom of gas may not stay dissociated so long as at a lower temperature, while in a liquid this interval will not be sensibly affected by the temperature.

It is thought that the law of Dulong and Petit receives reasonable explanation on the hypothesis that the ultimate atoms have each the same kinetic energy at the same temperature, as will be shown in a subsequent paper: but perhaps the strongest direct evidence in favor of the proposed hypothesis is found in the fact that even the simplest elements, such as hydrogen or mercury, have spectra of several lines at least, showing that the source of the light must be sufficiently complex to be able to vibrate in a number of different ways, such as may well be possible for an atom formed of a number of ultimate atoms, but such as is inconceivable in a molecule consisting of one or two perfectly hard atoms. H. T. Eddy.

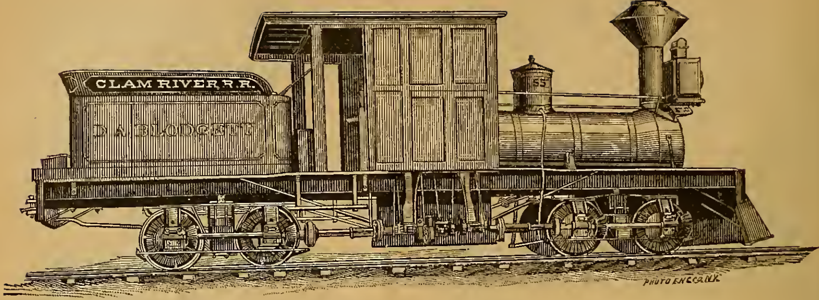
THE NATIONAL RAILWAY EXPOSITION.[1] — IV.

The exhibit of locomotives was remarkably complete, and comprised engines differing widely in size and power, and adapted for every variety of work; but a certain uniformity of the design of the main features would seem to indicate that locomotive practice has settled down into a certain groove, and that the methods of construction now adopted are so satisfactory that few exhibiters propose to greatly improve upon them by any radical alterations, though one or two of these new departures, such as the Wootten firebox and the Stevens valve-gear, seem likely to come into extensive use.

The main tendency of locomotive design seems to run rather in the direction of larger bearing surfaces and stronger working parts than in any novel methods of construction; while sound and accurate workmanship, and plenty of good material judiciously distributed, are relied on to make a locomotive durable, hard-working, and trustworthy under trying conditions.

Mr. E. Shay of Haring, Mich., exhibits a model of an engine of peculiar construction for 'logging' purposes. These small railways are exceedingly light in construction, and the rails and ties are generally laid directly on the surface of the ground, without any great attention being paid to preliminary grading or alignment; and therefore a suitable locomotive must unite considerable tractive power with great flexibility of wheel-base, and a small weight, on any one pair of wheels. Mr. Shay accomplishes this by using a Forney type of locomotive, having a pair of drivers under the barrel of the boiler, and a four-wheel truck, carrying the tank and fuel, behind the firebox. All the wheels being made of the same diameter, a pair of vertical engines are secured to one side of the firebox, working a longitudinal shaft which

[1] Continued from No. 25.



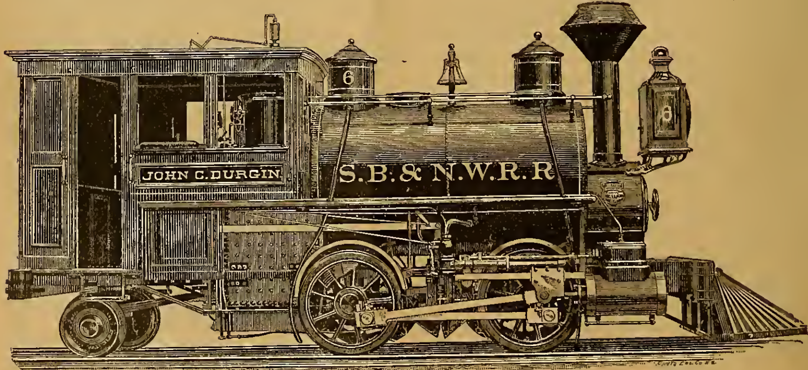
Logging locomotive with geared driving-wheels.

runs beside the wheels. Bevel pinions on this shaft engage bevel wheels on the hubs of the wheels, and, as the shaft is provided with universal and telescopic joints, the whole of the wheels can be driven simultaneously, no matter how sharp the curve over which the engine may be running; and, owing to the interposition of gearing, comparatively small-sized cylinders are sufficient to enable the engine to haul very heavy loads, and yet run sufficiently fast for the nature of the work.

Mr. Shay informs us that nearly a hundred of these engines are at work, some on wooden rails, and that they are giving great satisfaction. The mode of driving appears to be novel, and, despite some complexity, is free from many of the disadvantages of the Fairlie system, which also utilizes the adhesion of radiating axles.

Messrs. H. K. Porter & Co. of Pittsburgh, Penn., also exhibit an engine specially adapted for logging railways. Ordinary methods of construction are, however, followed; and the consequent greater simplicity is of great advantage where the work for a few months in the year is very severe, and no repair-shops are situated within convenient distance. The engine exhibited is of the following dimensions, and is calculated to work safely on a rail weighing only thirty pounds per yard: —

Cylinders, diameter and stroke	10 in. × 16 in.
Driving-wheels, diameter	36 in.
Truck-wheels, diameter	22 in.
Rigid wheel, base	5 ft. 3 in.



Logging locomotive exhibited by H. K. Porter & Co.

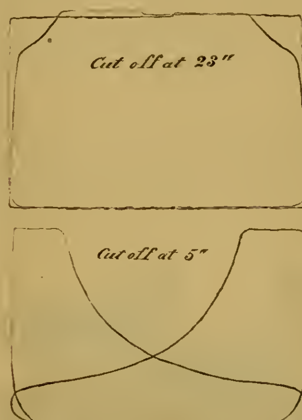
Total wheel base	13 ft. 4 in.
Weight in working order	31,000 lbs.
Weight on drivers	26,000 lbs.
Water-capacity of tank	500 gallons.

Messrs. Porter state that a similar engine, working day and night on a road 11 miles in length, with grades of 53 feet per mile, has handled 350,000 feet of logs in 24 hours, running about 180 miles in that time.

The engine exhibited is well designed, and the workmanship is fully equal to that on a first-class main-line engine.

The Cooke locomotive works of Paterson, N.J., exhibit an engine for the Southern Pacific railroad which is believed to be the largest locomotive in the world, the cylinders being 20 inches diameter by no less than 30 inches stroke. The designer of this engine, Mr. N. I. Stevens, general master mechanic of the Central Pacific railroad, is, however, building a still larger engine at the company's shops at Sacramento, Cal., the cylinders of which measure 21 inches by 36 inches. This latest development will exert a tractive force of 278 pounds for every pound per square inch average pressure on the pistons; that is to say, with an average pressure on the pistons of 100 pounds per square inch throughout the stroke, this engine would exert a tractive force or pull of 27,800 pounds, less the internal friction of the working-parts of the engine. Whether the average drawbar of the average freight-car is capable of safely standing such a strain is a question which experience will probably solve in a direction unfavorable to weak draw-gear. Apart from their immense size, these engines are interesting as being fitted with a novel form of valve-motion. The engine exhibited has four slide-valves to each cylinder, two main valves, and two riding cut-off valves. An excellent diagram is obtained, the cut-off being sharp, and the compression very slight; and the gear seems well adapted to a slow-running freight-engine. In the later and larger engine, but two valves are employed, and but one eccentric; motion being taken from the engine crosshead. The results of this simpler gear promise to be equally good, and the trial-trip of this engine will be looked forward to with great interest.

The Grant locomotive works are the makers of the only engine which departs from the sober suit of black in which its competitors are arrayed; and further examination shows that its peculiarities are not confined to the outside appearance, but extend to the fuel to be used, which is entirely novel in character. The inventor, Dr. Holland, proposes to raise steam by means of the combustion of decomposed water. The heat evolved by burning naphtha is used to separate the oxygen and hydrogen in superheated steam; and, the carbon of the naphtha kindly uniting with the oxygen thus set free, the hydrogen is burnt by means of oxygen obtained from atmospheric air. The inventor states that the only products of this combustion are carbonic acid and water, the nitrogen disappearing in some mysterious manner not yet fully understood. The old fallacy that water can be decomposed and then reunited, with a positive advantage as regards heat, is here again illustrated; while the strong smell of burning naphtha during the trial of the engine in the exposition indicated that this convenient auxiliary was used to a considerable and probably wasteful extent.



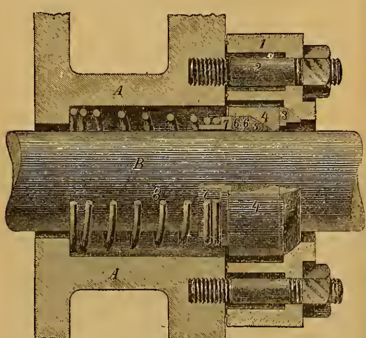
Indicator diagrams obtained on locomotive built at the Cooke locomotive works.

The Philadelphia and Reading railroad exhibit a fast passenger-engine fitted with Wootens' patent firebox, which is adapted to burn any waste or inferior quality of fuel. Reversing the usual practice on locomotives, the combustion on this engine is slow, owing to the enormous area of the grate (72 square feet), instead of a small one (16 or 17 square feet), while the blast is not severe, and the fire is one-third the usual thickness (4 inches instead of 10 or 12 inches); the result being a less vivid combustion, the interior of the fire-box being dull red in place of the white heat usual when a locomotive is at work. Trials at Chicago seemed to indicate that the engine was capable of maintaining steam with almost any kind of fuel, and that the lignite and inferior coal of the new north-west, which often contains only thirty-five per cent of carbon, can therefore be utilized under locomotives.

The slow combustion does not produce a heat intense enough to fuse the slag, and therefore the firebars keep clean and free from clinker; and it need hardly be pointed out that this is an important practical consideration in dealing with fuel which contains over fifty per cent of ash.

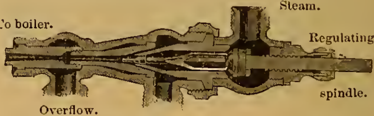
The large grate area is obtained by placing the fire and grate bars completely over the driving-wheels, where plenty of width is obtainable; and the firebox is accordingly made no less then 8 feet wide inside, instead of the usual 33 inches. It might be anticipated that the increased height of the centre of gravity would tend to make the engine unsteady at a high speed; but a precisely opposite result is obtained, as the engine rides with remarkable steadiness and smoothness, even at the highest speeds.

The Shaw engine has been so often described, and been so prominently before the public, that it is only necessary to say here, that, though exhibited at the Chicago exposition, want of time prevented any proper scientific tests being made to ascertain the real value of the invention.



METALLIC PACKING FOR PISTON-RODS.

Various forms of metallic packing for piston-rods are now being extensively used with ex-excellent results, the wear of both rod and packing being very slight, while the use of anti-friction metal obviates the frequent renewals necessary with hemp, rubber, and other packings which are destroyed by heat rather than by wear. In the packing which we illustrate, provision is made for any inaccuracy in fitting by allowing the piston-rod some play in the stuffing-box; the vibrating cup, 4, sliding on the ball and socket ring, 3. As the packing rings are pressed to their work by a spring, it is impossible for a careless engineer to screw his packing too tight, or to make it bear on one side only of the rod.



MACK'S IMPROVED LIFTING INJECTOR.

The National tube-works of Boston, Mass., exhibited an injector at work, which possessed some points of novelty, and appeared to be well adapted for use on locomotives working with bad water. The very fact that a simple arrangement of hollow cones can enable steam to lift and force water into a boiler working at the same pressure is in itself a remarkable paradox; but Mack's injector, as shown at work in the exposition, forced a small quantity of water into a boiler working at two hundred pounds per square inch when the injector itself was only supplied with steam of half that pressure. The apparatus was so arranged that the quantity of water forced against different boiler-pressures by the same pressure of steam could be readily gauged; and the results were interesting as showing what a large range of work can be performed by an apparatus which has no moving parts. The injector is made in several pieces, so that it can be readily taken apart, and cleaned of scale deposited by hard or lime water. When the injector is started, the water is lifted by means of a jet of steam, which rushes through a very fine hole running longitudinally through the centre spindle; the injector becomes full of water, which escapes at the overflow; the regulating spindle is then screwed back, and the large volume of steam thus admitted is condensed by the water already in the injector, mingles with it, and the momentum of the steam due to its great velocity (some five thousand feet per minute) drives the combined steam and water into the boiler.

THE INTERNATIONAL FISHERIES EXHIBITION.— THIRD PAPER.

IN eight weeks over seven hundred thousand persons have visited the exhibition; and there are no signs of any decrease in the daily attendance, which averages from twelve thousand to eighteen thousand, except on Wednesdays, when, the price of admission being half a crown instead of one shilling, the number is only about half as great. Wherever one travels by public conveyance, some of his neighbors in the car or the omnibus are always laden with the ponderous blue catalogue of the exhibition. London is thoroughly permeated by the interest in fish and fisheries. On Sunday I felt a desire for a change of topic, and sought refuge under the dome of St. Paul's; but the canon of Worcester, who officiated at the service, preached a sermon on the miraculous draught of fishes.

Since the middle of July the galleries have been lighted by electricity until ten o'clock. The result has been very satisfactory, the illumination in many cases being more effective than that by sunlight. The annoyance of heavy shadows is avoided by the use of a large number of lamps. All the principal systems being represented, there is an excellent opportunity for comparison. The following is the official distribution of the electric lighting of the exhibition: —

1. Siemens Brothers and company (limited)	Conservatory	4 arc-lights, 6,000-candle power.
	Main gallery, Great Britain	1,200 incandescent lamps (Swan).
2. Swan united company (limited)	Royal pavilion	280 incandescent lamps (Swan).
3. Gülcher electric-light company (limited)	China, New South Wales, etc.	600 incandescent lamps (Crookes).
	Canada and United States, Norway and Sweden	30 arc-lights, 1,000-candle power.
4. Electric-light supply company (limited)	Fish-market	7 arc-lights (Volta), 50 incandescent lamps.
5. Ferranti, Thompson, and Ince	Aquarium and west corridor	1,000 incandescent lights
	Machinery in motion, Electric-light machine-shed, Greece, Italy, Great Britain	25 arc-lights (Ferranti), 5,000-candle power each.
6. H. Edmunds	Promenade	50 arc-lights.
	Upper terrace	6 large arc-lights on mast.
	Eastern corridor and fine arts vestibule,	500 incandescent lamps.
7. Charles Lever	Council-room, Lecture-hall, Dining-rooms, Kitchens	28 arc-lamps (Lever).
8. Jablochkoff electric-light company (limited)	Netherlands, Belgium, Part of the United States, etc., Part of Sweden, etc	60 lamps (Jablochkoff).
9. Mackie	Life-saving apparatus shed	15 arc-lamps (Lea).
	Board of trade shed	6 arc-lamps (Werdemann).
10. Brockie	North corridors, for exhibition of stuffed fish	20 arc-lamps (Brockie).
11. Gérard	Spain and Russia	36 arc lamps (Gerard).
12. Sun-lamp electric-light company	Entrance vestibule	24 lamps (Soleile).
13. Goulard and Gibbs	Sixteen stations in different parts of the building	Arc and incandescent lamps of various characters.

I have been particularly interested in studying the adaptability of the various lights to museum purposes, and am thoroughly satisfied that a few large arc-lamps are preferable to a great number of small ones. The light seems softer, more powerful, and more evenly diffused, in a room like the main gallery assigned to the United States, where there are six lamps in a room fifty by a hundred and forty feet, at a distance of perhaps fifteen feet from the floor, than by a system like that in the British sea-fishery gallery, where the twelve hundred Swan incandescent lamps are used 'to demonstrate the possibility of lighting large areas by incandescence,' as the official catalogue states. Thirty lights of the Gülcher or Edmunds patterns would give a much better effect in this great shed, eight hundred and forty by fifty feet in dimension. The effect of a large number of incandescent lamps disposed along the roof of a room in every direction is very bewildering: they detract the attention, and give one the feeling that a long stay will be sure to result in a headache. In the Chinese court the Crookes incandescent lamps are used, each suspended under a shade of brightly-colored glass: the general effect is rather pretty, but the collections are scarcely discernible.

My observations at the exhibition have been confirmed by what I saw at the Royal college of surgeons at the conversazione recently given by the president and Lady Wells. The museum was perfectly lighted by about six arc-lamps in each of its spacious halls. The arc-lights, too, are used in the art museum at South Kensington with very excellent effect; six of them accomplishing what is done, no more effectively though perhaps more agreeably, in a hall of the same size by about two hundred gas-jets. The expense of lighting some twenty halls by gas in this generous manner must be far greater than by electricity.

On the 18th of June the International fishery conference began its sessions in the conservatory of the Royal horticultural society, adjoining the exhibition galleries. Meetings have since been held every day except Wednesdays and Saturdays. The inaugural address was delivered by Professor Huxley, and was an admirable introduction to the papers which were to follow. First referring to the antiquity of fisheries and their influence upon the history of man, he spoke at some length of the fisheries of the Phoenicians, the Romans, and the early Britons. Insisting upon the importance of fish as food, he next took up the question, 'Are the fisheries exhaustible?' and, after tacitly admitting that certain fisheries may be destroyed, went on to describe the enormous abundance of cod, mackerel, herrings, and sardines, and to express his firm belief that their numbers cannot be effected by human agency. He concluded with a very strong condemnation of unnecessary legislation.

Upon this occasion the Prince of Wales presided, and there was an impressive assemblage of diplomats and state officials. On the following day the prince again was present, and read a paper an hour and a half in length, written by his brother the Duke of Edinburgh, who is absent in Russia attending the coronation of the czar. This paper, entitled 'Notes on the sea-fisheries and fishing population of the United Kingdom,' is in many respects the most remarkable which has been presented to the conference. It is by far the most exhaustive and scholarly essay on the fisheries of Great Britain which has ever been published, and contains a great store of valuable facts gathered by the Duke of Edinburgh during the three years in which he served as admiral in command of the naval reserve, together with extensive statistics obtained at his instance by the men of the coast-guard. On the 21st Sir James Gibson Maitland, the proprietor of the most extensive fish-cultural establishment in Europe, located at Howieton, near Stirling, read a paper on the 'Culture of Salmonidae and the acclimatization of fish,' and the following day Professor Leone Levi of University college, London, on the 'Economic condition of fishermen,' — an important contribution to social economy. On Monday, the 25th, the American commissioner read a paper on the 'Fisheries of the United States and the work of the U. S. fish-commission.' Mr. James Russell Lowell occupied the chair, and made one of his wise and witty little speeches which are so thoroughly enjoyed by the English people.

On the 28th Mr. R. W. Duff, M.P., spoke on the 'Herring fisheries;' on the 29th Prof. A. A. W. Hubrecht of Utrecht university, on 'Oyster-culture and the oyster-fisheries in Holland,' and Mr. R. B. Marston, on 'Coarse fish-culture,' — 'coarse fish' in England signifying fresh-water fish other than the Salmonidae. On July 1 Mr. L. Z. Joneas read a paper on the 'Fisheries of the Dominion (of Canada);' and, on the 3d, Professor Huxley spoke most instructively upon the 'Diseases of fishes,' confining his remarks to the history of the salmon-infesting Saprolegnia ferax. On the 5th several of the commissioners from continental European nations spoke of the fisheries of their respective countries, and on the 6th Capt. Temple gave an account of the antarctic seal-fisheries.

The discussions have been in some instances important, though the usual disposition to ramble has been difficult to check. In fact, the ponderous British system of closing each session with four formal speeches, in connection with the votes of thanks to the chairman and the speaker, has rather tended to encourage the utterances of generalities. The 'practical men,' as they style themselves, who take the very unnecessary precaution of informing their hearers that they make no claim to being 'scientific,' have been rampant at these meetings. Professor Huxley's inaugural address has caused great unhappiness to those who believe in legislative protection without limit or reason. Close seasons for river-fisheries are needful and useful; but what is to be done with economists who claim that legislation will relieve the salmon from its pestilential parasite, the Saprolegnia ferax?

The juries began their sessions about the middle of the month; and the galleries are still daily invaded by enterprising little groups of men with note-books. Their task is not a light one; for the number of exhibiters must be at least three thousand, and the heat is greater than London has known since 1860. Science is well represented among the jurymen: Professor Flower, Professor Allman, Mr. John W. Clark of the Cambridge museum, Mr. Henry Woodward of the British museum, Professor Moseley of Oxford, Mr. John Murray of the Challenger, Lord Russell, Dr. Murie (secretary of the Linnaean society), Dr. Francis Day, Professor Huxley, Mr. R. H.

Scott, Professor Ray Lankester of University college (London) and Professor Jeffrey Bell of Kings college, Dr. Spencer Cobbold, Mr. Romyn Hitchcock of New York, Mr. R. E. Earll of Washington, Dr. Hubrecht of Utrecht, Professor Smitt, Professor Torell and Dr. Trybom of Sweden, Dr. W. A. Buch of Norway, Professor Giglioli of Florence, Dr. Steindachner of Vienna, and Mr. E. P. Ramsay of the Sydney museum (New South Wales), — are all here in the work. Just before the opening of the exhibition, *Nature*, in an editorial, after stating that the management of affairs had been trusted almost entirely to 'practical' men, to the exclusion of English men of science, expressed some doubt as to whether this policy would effect as satisfactory results as that of the Berlin exhibition. It would be interesting to know how far this hint has influenced the action of the executive committee. The committee has shown itself singularly sensitive to the voices of well-meaning advisers, and changes are constantly being made for the better in the management of affairs. For instance: the conference chamber has been removed from the conservatory, where it was torture either to speak or to listen, to one of the picture-galleries near the main entrance; and the experimental fish-market in connection with the exhibition has been thrown open to the public without admission-fees, and a separate entrance cut through from Exhibition road.

The papers read at the conferences are being printed in full, together with the discussions which follow them, and will form a valuable little library, when supplemented by the shilling handbooks to the exhibition, which are being rapidly printed. Fifteen of these handbooks are announced, in addition to the eighteen or more 'papers of the conferences.' The literature of the exhibition is reserved for future discussion. It is much to be hoped that the authorities will crown the series with an illustrated report, prepared by scientific committees, similar to the valuable 'Amtliche berichte über die Internationale fischereiausstellung zu Berlin.'

The closing address at the conference by Professor Ray Lankester will be upon 'The scientific results of the exhibition.' It would not be surprising if Professor Lankester were to choose to act the part of the prophet rather than that of the recorder, and to point out in his discourse what the exhibition ought to do for science. A number of prominent educators and investigators have already addressed to the executive committee a memorial advocating the establishment of a national marine zoölogical station with a part of the surplus funds, which, from present appearances, are likely to remain over at the end of the exhibition. In another letter I hope to review briefly the most important features of the exhibits of the several countries. G. Brown Goode.

Richmond Hill, July 10.

THE PARIS OBSERVATORY.

We abstract from *Nature* the items of chief interest in the report of Admiral Mouchez, the director of the Paris observatory, on the state of that institution during the past year. Its service has been considerably deranged by the preparations for the transit of Venus. The various members of the expedition attended the observatory to be trained either in photography or in the use of the artificial transit, and no less than five of the *personnel* of the observatory themselves took part in the work. The grounds of the observatory have been extended, the equatorial *coudé* has been installed, and several underground chambers have been constructed for the purpose of studying magnetism and terrestrial physics generally. A revision of Lalande's catalogue of stars, numbering forty thousand, has been going on for the past four years. The general catalogue, which will form eight volumes in quarto, is well in hand; and four volumes will be published during the next three years. Meridian observations, numbering a hundred and ten thousand, have already been made, to assist in the construction of the catalogue.

The common inconveniences attending the use of equatorials of the usual form of construction have led M. Loewy to conceive the idea of adapting to the equatorial the system of '*lunette brisée*,' employed first in England, and afterward to a greater extent in Germany, especially in small transit instruments. The new *coudé* equatorial may be thus described: the polar axis of the instrument is supported at its extremities on two pillars, like a meridian instrument; round this axis the telescope turns, forming a right angle at the lower support; by means of a mirror placed at the summit of this angle, the light is reflected along the pierced axis, at the end of which the eye-piece, or micrometer, is placed. Under these conditions, with the telescope at rest, objects on the celestial equator pass across the observer's field of view. In order to secure the observation of objects not on the equator, a mirror free to rotate is placed before the object-glass, and connected with the declination-circle. The inclination of this mirror may be changed so as to throw into the tube the light coming from a star of any declination. The observer may thus explore every part of the heavens without quitting his position at one end of the polar axis. The telescope may practically, by a rotation of this axis, be directed toward any part of the celestial equator, whilst a star of any declination may be made to throw its light down the broken telescope by means of the external mirror. Preliminary experiments have shown that this double reflection does not occasion a great loss of light; and the figure and polish of the silver on glass mirrors are very satisfactory. The observatory possesses this new instrument through the liberality of the well-known patron of French astronomy, M. Bischoffsheim.

In regard to physical observations, M. Egoroff, professor of physics at Warsaw, was occupied at Paris during the months of July and August, as in preceding years, with the spectroscopic study of atmospheric absorption, working with a beam of electric light sent from Mont Valérien to the observatory. In consequence of the decision of Admiral Mouchez to separate special meteorological investigations from the astronomical work of the observatory, meteorological observations of a much higher value are now being made, with the special object of determining the different corrections, of the nature of refraction, to be applied to the astronomical observations. A series of observations is to be made from a captive balloon of such size, that, with ordinary gas, it can, in calm weather, take self-registering barometers, thermometers, and hygrometers up to a height of five hundred, and with pure hydrogen to a height of eight hundred metres. The balloon cannot be well managed if the velocity of the wind exceeds four or five metres per second; but this is not regarded as inconvenient, because it is during complete calm that the greatest abnormal perturbations of astronomical refraction manifest themselves. Simultaneous observations will be made on the meridian of the Paris observatory, north at the observatory of Montmartre, and south at the observatory of Montsouris.

The construction of the great refractor of 16 m. focus, together with its dome 20 m. in diameter, is steadily progressing. The object-glass figured by M. Martin is already complete. The dome is to be of the same dimensions as the Pantheon, and the largest ever attempted. The arrangement for insuring its turning with ease, and which has been adopted for its construction, is that proposed by M. Eiffel. In order to reduce to a minimum the friction of circular rollers, he proposes to float the dome by means of an annular *caisson* plunged in a receptacle of the same form, and filled with a liquid which will not freeze, such as an aqueous solution of chloride of magnesium. At the Paris observatory it is quite necessary that some such arrangement as this should be adopted; for the observatory is situate over the catacombs, one result of which has been, that for many years the pillars of the meridian-circle erected in the gardens have gradually inclined toward the east in consequence of the displacement of the soil. With mechanism of this form for rotating the dome, any probable change of level would not prevent the dome from turning.

The magnetic observatory now being completed will be one of the first order. Six subterranean chambers of constant temperature have been built under the best possible conditions of isolation and stability. An outer wall of nearly 2 m. thickness encloses a rectangular space 40 m. in length and 14 m. wide, completely impervious to moisture. The vaulted roof, 1 m. thick, is covered by earth to the thickness of 2 m., and grass and planks protect the soil from the direct rays of the sun and from frost. The observing chambers can be lighted either by gas, or by reflection from without.

Advantage has been taken of the existence of these chambers by placing in them the clocks from which the time is distributed throughout Paris; but, in spite of all precautions, the chambers are found to be not altogether free from minor trepidations resulting from the traffic of the streets. Apparatus has been constructed, and is now ready for use in investigating the vertical and slow movements of the soil. This will be placed in a gallery in the catacombs 27 m. below the surface.

The erection of an astronomical observatory on the Pic du Midi, at a height of 2,859 m., is engaging the attention of the director. At this elevation, it is said to be easy to read at night by starlight alone, and fifteen stars are visible to the naked eye in the cluster of the Pleiades. It is intended that any astronomer who wishes to make any special researches may take advantage of the observatory on the Pic du Midi.

LETTERS TO THE EDITOR.

The right whale of the North Atlantic.

I HAVE noticed in a late number of your journal a criticism on the last Bulletin of the American museum of natural history. Being away from town, I have not access to works referring to the subject of cetology; but with the aid of notes that I have with me, as well as drawings of the subjects involved, I hope to show conclusively that other views than those taken by the critic are the correct ones.

I shall not attempt to justify the carelessness that permits the presence of typographical errors; but, when an *errata* list accompanies a work, it should have due credit for its intentions.

The writer says, "There are errors of statement of so grave a character as to require notice," and continues, "It would seem, for instance, that only the merest novice in cetology could have been misled," etc. — referring to the identity of the St. Lawrence whales.

Lesson wrote, "What an impenetrable veil covers our knowledge of the Cetacea! Groping in the dark, we advance in a field strewn with thorns." I believe that some in later days, not quite novices, admit a degree of unfamiliarity with the great beasts of the sea. In that view, let us see if 'errors of statement of grave character' have really been made.

The president of the Quebec historical society, Dr. Anderson, with Dr. DeKay's Report on mammalia before him, says, speaking of a large whale that had foundered in the St. Lawrence River, "It turned out to be an aged male, apparently the species Balaena mysticetus. . . . The back was black; the belly, furrowed, presenting the appearance of a clinker-built boat. . . . I concluded, after a careful examination, it answered fully the description given by Dr. DeKay for the mysticetus. . . . As the whale lay upon the beach, he was sixty-five feet long; the fluke of his tail was twelve feet; his jaw, fifteen feet."

This whale was noticed primarily by us for the purpose of directing attention to the fact, that such a great form had really pushed into the fresh-water stream as far as Quebec, and to show that possibly Professor Flower had misapprehended when he was told of stranded whales in the St. Lawrence; he, in absence of description, naturally regarding them as white Belugas.

Besides this, several alternatives were presented in the absence of the mention of *most distinctive* characters; but no definite statement was hazarded, nor was one intended.

The first paragraph touching on this notice of the St. Lawrence whale, and which is included by the critic as among the 'grave errors of statement,' is as follows: "It is pretty certain that if the creature was really a Balaena, and not a Balaenopter, it was an example of unusual size." As we had no intention of arguing any case, this cannot be regarded as more than courtesy to Dr. Anderson, who had stated his unqualified opinion as above.

The next passage in our text is, "The furrows on the belly naturally suggest the Balaenopters; but it is inferred that there was no dorsal fin." The dorsal adipose fin being an essential feature in the latter, absence of any notice of it naturally seemed strange.

As there was no description of the head, save as related to its length, the baleen not being measured, the only character that suggested strongly the fin-back was the clinker-built aspect of the belly. In this view the statement of Scoresby might well lead to misapprehension, even by some not wholly novices.

Scoresby says (in his description of the B. mysticetus), "The skin of the body is slightly furrowed, like the water-lines in coarse-laid paper."

The fluke of the tail is described as twelve feet in length. Here, regarding the possible fact of there being *two* flukes to the tail, the total width of the caudal extremity would be twenty-four feet, the actual measurement of a large example of a right whale. That the writer in the bulletin did so regard it is true; but, in the light of after-knowledge, we have no doubt that Dr. Anderson meant to include the whole width as twelve feet.

In the absence of definite features in Dr. Anderson's description, and in view of the absence of any attempt in the bulletin to argue in favor of any one genus or species, we regard it as a subject that hardly calls for criticism. In short, taking the evidence recorded, to our mind it seems to be quite as easy to prove the creature of one genus as the other; and by that we mean that Dr. Anderson's positive statements should not go for nothing. We are not, however, ready to hazard an opinion that the whale was not a fin-back, as we certainly did not in the bulletin.

The next point refers to Scoresby and his drawings. That Scoresby did not portray his subject correctly, so far as relates to the Greenland whale, is, we feel sure, susceptible of demonstration, even if we should omit the opinions of three of the most able cetologists. The critic claims, "That it was the best figure [Scoresby's], if not quite correct in all points, of the species down to 1874, when Scammon's admirable illustration was published, has, I think, hitherto been unquestioned." When we are told that our opinion that Scoresby 'furnished to science an incorrect figure' is 'an error of statement of so grave a character as to require notice,' we answer by quoting from Professors Eschricht and Reinhardt, in their article on Greenland whale, in Ray society's publ., p. 29. It is well known that these distinguished authors are leading cetologists, whose work is edited in English by Professor Flower. The latter, therefore, is supposed to acquiesce in their opinions. These authors say, "We must confess, that as to proportions we confide more in these drawings [referring to Marten's and Zorgdrager's] than Scoresby's, which certainly represents the Greenland whale (B. mysticetus) more slender than it really is."

Besides this, we claim to be able to demonstrate the correctness of our statement by reference to the figures. We have before us those of Scammon, Scoresby, Zorgdrager, and Lacépède, representing the Greenland whale. We also have the Bachstrom figure of nordcaper, published in Lacépède's work. With Capt. Scammon's figure before us, the one admitted by our critic to be an 'admirable illustration,' compare now Zorgdrager's; and we find, that, though rude in finish, it is nearly an exact counterpart of the Scammon figure. We see that the form is bulky, and has a very short 'small,' or caudal region; that its head is of the proportion of one-third the total length of body; its pectoral limbs are situated very closely behind the eye and angle of the mouth, not a quarter of the total length of the 'flipper' distant therefrom, — all of which features are recognized as correct.

Let Scoresby's figure be compared with Zorgdrager's, which we have seen is essentially the same as Scammon's. We see that the form is not only not bulky, with a very short 'small,' or caudal region, but has the body very slender, with an elongated 'small;' the latter being so slender that it is represented whipping the air like the tail of a saurian. Its head is one-fourth of the total length of body, instead of one-third, as in nature, and in the Zorgdrager and Scammon figures. Its pectoral limbs are situated at a distance from the eye and angle of mouth represented by the *total* length of the limbs. It is therefore seen, that, in accordance with all evidence, Scoresby's figure was not correct. Hence it *is* "deplorable that nearly every book published to this day has an illustration copied from Scoresby."

"'Tis true 'tis pity, and pity 'tis 'tis true."

Our critic next attributes unfamiliarity with Scoresby's cetological writings, from the fact that we credit Godman with 'an amount of anatomical knowledge quite unusual.'

The truth is, the edition of Scoresby in our possession does not contain the portion relating to interior anatomy and physiology, and the plates representing the spiracles. It is 'An account of the arctic regions, Edinburgh, 1820.' The work is not before us, but a reference to this edition will verify our statement. Since the matter was prepared for the bulletin, we find that the several pages relating to this portion of Scoresby's description were probably never printed therein. We have, however, found the whole in Sir William Jardine's Naturalists' library, volume on whales, by Col. Hamilton.

In view of this fact, one may venture to claim a degree of immunity from severe criticism, though evidently he may be open to the accusation that 'he is none too familiar with Scoresby's cetological writings,' or at least his various editions.

Not having met with this matter relating to the anatomy and physiology in Scoresby's book, it was but natural to attribute to Godman 'an amount . . . quite unusual.'

A point succeeds this, concerning which we must take issue with the critic. He says, "The fact being that Godman's account is an unaccredited compilation from Scoresby's work, whole pages being taken entire," etc. We find in our edition of Godman's Natural history, instead of 'an unaccredited compilation,' the following: "Having never personally enjoyed opportunities of studying the whale in his native floods, and having derived all we know in relation thereto from Scoresby, we should deem it injustice to the reader to give this account in any other language than that of the original. We do this without reluctance, as our object is to convey the most accurate knowledge, rather than produce a work exclusively of our own composition. All that follows in relation to the whale is selected from the different works of the accurate and philosophical Scoresby." If the critic's edition of Godman has played false with him, as our edition of Scoresby has with us, perhaps he may think it wise to 'cry quits,' and join with us in throwing out of the case the two slippery points.

It may be proper to add here, that we are familiar with Scoresby's second figure of mysticetus, which is so far improved as to have the 'small' shortened; but unfortunately the first figure, with all its imperfections, is the one that has been brought down to us through every book on natural history.

The reference to Bachstrom's figure of nordcaper is obscure.

It matters not what that figure *is:* it was regarded as one of nordcaper by Cuvier; and he, in comparison with the old figures of mysticetus, which we claim were nearer true than Scoresby's in general proportion, wisely admitted two species.

They were both, as we have said, about equally incorrect; yet they both had certain features that agreed with the descriptions of the two forms. The nordcaper had been described in nearly the same terms by various authors, great stress being laid on its slenderness and mobility. Scoresby now presents his figure, which, instead of being bulky, with a very short 'small,' or caudal region, and a head one-third the total, had quite nearly the proportions of the figure of Bachstrom, received by Cuvier as that of nordcaper, and with no other specific feature to distinguish them.

The mention of inaccuracies, seen near the close of the criticism, is not wholly free from error; for example: the citation touching Col. Hamilton and the Naturalists' library is exactly correct, yet it is noticed as one of the errors that render the historical *résumé* 'seriously defective and misleading.' We are now willing to rest this showing, trusting to the facts herein referred to for our vindication in the face of this grave charge. J. B. HOLDER.

Fortunately for Dr. Holder, he did not state directly and unequivocally that the St. Lawrence whale was a Balaena; but he occupies several pages in trying to explain away the obvious discrepancies in the way of such an identification and in offsetting them with the *possibilities* in its favor, leaving the reader with the conviction that the specimen is cited as, in Dr. Holder's opinion, an instance of the occurrence of a Balaena in the St. Lawrence near Quebec. Indeed, he goes so far as to say, "and the second example [the one here in question] . . . shows that the largest of the right whales [Balaena] have really found their way as far up a fresh-water stream as Quebec and Montreal" (p. 116). Again he says, "This example is valuable for record, 1°, as a specimen of unusual size; 2°, as one of great age; 3°, as one out of its usual habitat in so far as to be quite within fresh water" (p. 115). From the context, the point in doubt seems to be, not whether the species is a Balaena, but whether it is B. cisarctica or B. mysticetus; and the whole tenor of the argument (for such it really is) is fairly open to only this construction, whatever may have been intended. In evidence that my criticism on this point is not groundless, or due to perversity on my part, I may cite Mr. F. W. True's notice (*Scient. lit. gossip*, i. 72) of Dr. Holder's memoir, where the same criticism is made.

As to other points, I will take space to say merely that I regret to notice that Dr. Holder forgets to tell us where Scoresby got his drawings, which, he (Dr. Holder) informs us, 'were evidently ill-considered and taken at second hand,' and to ask for proof that Col. Hamilton wrote the 'Cetacea' of Jardine's 'Naturalists' library.' The copies of the work I have seen are anonymous, but the work is accredited by Gray and other cetologists to Jardine; and some time since, I took pains to satisfy myself that Jardine was the author. As to Godman, I confess to having done him injustice in overlooking his credit to Scoresby, which my friend Dr. Holder appears to have unfortunately only recently discovered; otherwise, doubtless my stricture on this point would not have been called out. J. A. ALLEN.

The Ainos of Japan.

On p. 307 of SCIENCE, D. P. Penhallow objects to my statement of the number of Ainos. It is rather surprising how little he heeds what I said. The numbers he gives are official; i.e., he gives the number of Ainos known to the Japanese government. Therefore he reaches the surprising result, that, with the exception of the Ainos brought over from Saghalien (now about 800), there are but 200 in all the province of Ischicari. That province is about as large as Hitaka (according to Penhallow, with 5,000 to 6,000).

Penhallow gives the Aino population in Kitami, Kushiro, Tokachi, and Teshiwo as ranging from 350 to 1,500 in each, when it is well known that they are full of Ainos, as any one travelling there will see, their villages being thickly scattered along the coast and the banks of all the larger rivers. I should estimate from those seen at such points that there must be more than 50,000 Ainos in all. Taking Penhallow's figures for Iburi and Hitaka as correct, and assuming that the four provinces named above must have as many Ainos as Hitaka, we should have about 26,000 in these five. Granting that Ischicari, Shiribeshi, and Nemuro have also been taken as much too thickly populated, still we must give them 4,000 more than Penhallow allows; i.e., about 6,000.

Now add to them Penhallow's number for Iburi, nearly 4,000, and the small remnant of Oshima, (Penhallow, 250), and lastly for Chishima (not Chisuma) or the Kuriles a minimum of 750, we get 33,000 as the minimum for Yezo. Saghalien having 10,000 to 12,000, and South Kamtchatka 5,000 to 6,000 (perhaps less), there cannot be fewer than 50,000 Ainos altogether. D. BRAUNS.

The Iroquois.

A close study of the Mohawks of Quebec province, Canada, after the plan and in the service of the Bureau of ethnology, reveals several facts hitherto unnoticed in the various histories of the Iroquois.

Isolated by the early Jesuit fathers from their former Pagan friends and surroundings, every trace of their old folk-lore and of their Pagan customs has disappeared. The division and nomenclature of their gentes differ materially from those of any of the other tribes, and present an interesting field of inquiry. The Mohawk gentes, as given by Morgan, are the wolf, bear, and turtle. Among the Mohawks at Oka, we find, in addition to those, the lark and the eel, while at Caughnawaga they are the bear, wolf, calumet, rock, lark, turtle, and dove.

Among the wampum belts of this tribe is a very fine one, upon which the calumet is figured in white wampum beads, the remainder of the belt being in dark purple. This probably belonged to the gens bearing the name of the calumet, and whose office it was to prepare and present the grand calumet in all the solemn assemblies.

The effect of the isolation of this tribe upon its language is also an interesting and important study. Through the courtesy of Superior Antoine and Père Burtin, I have obtained access to an invaluable collection by the French missionary Marcoux, which will furnish Mohawk synonymes for a dictionary of the six Iroquois dialects, for which thirty thousand words have already been gathered. Erminnie Smith.

203 Pacific Ave., Jersey City.

Many snakes killed.

The number of snakes killed near this city during the late overflow of the Nemaha River is almost beyond belief. They were driven by the water from the bottom-lands to the higher grounds, and especially to the embankments thrown up across the bottom for the Burlington and Missouri and the Missouri Pacific railways. It is estimated that more than three thousand snakes were killed within a mile of this town. They were chiefly garter snakes; but water moccasons, blue racers, and rattlesnakes were also killed. A horse was confined in a pasture surrounded by a wire fence in the overflowed district, and, when released, it was found that several snakes had taken refuge in the long hair of his mane. Since my residence here, I have travelled nearly all over this county, a portion of the time engaged in geological explorations; yet, up to the time of the present June overflow, I had failed to see half a dozen snakes all told. The overflowed district along the Nemaha would not average over a mile in width; and it is astonishing where so many snakes found hiding-places. Undoubtedly, nearly all the snakes in this county are confined to the creek and river bottoms.

Stephen Bowers.

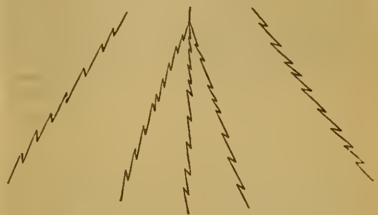
Falls City, Neb., July 10, 1883.

Swallows in Boston.

Has any one seen a swallow in Boston this summer? The old proverb says, 'One swallow does not make a summer.' Have we a summer and not one swallow? Carl Reddots.

Singular lightning.

On the evening of July 4, 1883, I noticed some lightning which differed from any that I have previously seen. About sunset a mass of very threatening clouds, accompanied by heavy rain and lightning of the usual character, rose in the north-west, and, following an easterly course, passed a little to the northward, giving us a few drops of rain from its ragged southern edge. It was quickly succeeded by a comparatively thin cloud-stratum, — apparently the after-birth of the main storm, — the course of which was directly overhead. During the passage of this cloud, rain fell briskly but not heavily for perhaps half an hour, and rather frequent flashes of lightning preceded and followed the first sprinkle. Owing to my position on the eastern side of a large building, I could not see the earlier flashes; but their light, thrown on the walls of neighboring houses, was noticeably rose-colored. At length, however, one came that could be accurately noted. It passed directly overhead, forking into five fine, thread-like lines of vivid yellow light. Each line was distinctly zig-zagged with sharp though not prominent angles. The divergence of the lines was nearly regular, but the outer pair branched at a greater angle than the inner three. The relative divergence was similar to that of the outstretched fingers of a human hand; but a still more accurate idea may be given by the following sketch.



The flash above described was followed, in a few minutes, by a second one, apparently similar, but less satisfactorily noted. After this the rapid passage of the storm carried the lightning beyond my limited space of observation.

I may add that none of the lightning from this cloud seemed to come to the earth, its course being on an apparently horizontal plane. The accompanying thunder was unusually deep and grand.

William Brewster.

Cambridge, Mass.

Deflective effect of the earth's rotation.

In Science for March 2 (No. 4), Mr. W. M. Davis says, "A correct knowledge of the deflective effect of the earth's rotation is generally accounted the result of studies made within the last twenty-five years."

This correct knowledge, he says, is still disputed by some authors.

By transferring the axis of rotation to the tangent plane on which the body is supposed to move, and resolving the earth's rotary motion into two motions, — one around the meridian of the tangent plane, and the other around a vertical to that plane, — it is easily seen, without recourse to the equations of motion, that the angular motion of the tangent plane with respect to a fixed plane will depend upon the angular rotation of the earth and the sine of the latitude of the tangent plane; from which it follows that the deflective force is the same, in whatever direction the body is supposed to move on any given tangent plane.

But in resolving the actual motion into two motions, respectively around the vertical to the tangent plane and around the meridian of that plane, we have neglected the effect resulting from the latter, — a consideration of which would have introduced another term, containing a function of, and therefore varying with, the cosine of the angle contained between the meridian and the line of projection of the moving body; we have also neglected the effect of the centrifugal force resulting from the motion of the body, which is a minimum when the motion is in the meridian, and a maximum when at right angles to the meridian, and therefore also variés with the cosine of the angle contained between the meridian and the line of projection of the moving body. When the velocity is considerable, both these terms become sensible; and therefore the deflective force is least when the body moves in the meridian, and greatest when the motion is at right angles with the meridian.

This conclusion is in conflict with the 'correct knowledge' above alluded to; viz., that the deflection of the moving body depends 'not at all on the direction of its motion.' But I may remark, that Routh (see Rigid dynamics, p. 192) has also given the subject a rigorous investigation by means of the equations of motion, and finds for the deviation to the right, in north latitude, two terms, — the one agreeing with the above, as found from the component about the vertical; and the other, a function of the cosine of the angle contained between the meridian and the line of projection of the moving body.

J. E. Hendricks.

Des Moioes, Io., July 16, 1883.

ALNWICK CASTLE ANTIQUITIES.

A descriptive catalogue of antiquities, chiefly British, at Alnwick Castle. Printed for private distribution. Newcastle-upon-Tyne, 1880. 11+210 p., 43 pl. 4°.

By the generosity of the Duke of Northumberland, the Boston public library has recently been made the recipient of a copy of this truly magnificent work, and of the companion volume descriptive of the important collection of Egyptian antiquities, also preserved at Alnwick. In no more satisfactory manner could the liberality and public spirit of the noble proprietor have been manifested than in thus sharing his treasures with the antiquaries and art-lovers of other countries. Such sumptuous volumes as these constitute a monument *aere perennius*, like those which illustrate the literary and artistic treasures of Earl Spencer at Althorp, or the magnificent publications in which the Archduke Ludwig of Austria has recorded his travels.

In its artistic and mechanical execution, this catalogue is beyond praise: never have we seen more beautiful or more faithful delineations of the various kinds of antiquities. If we cannot speak in quite such high terms of commendation of the accompanying letterpress, the fault should not be laid to the charge of Dr. Collingwood Bruce, upon whom devolved the task of preparing the work for the press. His competency as an antiquary has been sufficiently manifested by his able and thorough study of 'The Roman wall,' whose 'stations' have yielded to the explorer many of the objects described in the volume. It is to the untimely death of Mr. Albert Way, by whose assistance and advice much of the collection was gathered, who knew its contents thoroughly, and to whom the preparation of the catalogue had been originally intrusted, that any shortcoming must be attributed. Although several distinguished English antiquaries have lent their aid to the editor in their respective departments of knowledge, we miss the influence of one guiding mind, familiar with the results of recent archeological research in all its various branches, and capable of 'speaking the latest word' upon the many interesting and important topics suggested. Still the reader cannot fail to receive instruction from the accounts given of numerous relics of various periods in the ages long since past, while the beauty of many of the objects delineated goes far to justify the claim that, —

> "Not rough nor barren are the winding ways
> Of hoar antiquity, but strewn with flowers."

The expression 'chiefly British' in the title must be understood to mean that the greater part of the antiquities described have been found in Great Britain. Those first represented belong to the prehistoric periods of stone, of bronze, and of iron, and consist mainly of weapons and implements, such as axes and celts of stone, and swords and celts of bronze, or of a great variety of those rude, hand-made, sepulchral vases found in grave-mounds, in which was stored a supply of food for the dead. To the same remote ages are to be ascribed those singular markings found upon stones, known to archeologists by the name of 'cup-cuttings,' of which two remarkable examples occurring in Northumberland are represented. They are found in countries widely separated, and everywhere they closely resemble one another, and they have greatly exercised the minds of antiquaries as to their origin and significance. They consist of a series of shallow pits or cups, incised upon ledges, or, more frequently, upon bowlders. Of these, a central one is often found surrounded by one or more concentric circles; and a characteristic feature of such groups is a longitudinal groove extending from the central cup to beyond the outermost of the circles that surround it. That they are religious emblems is generally conceded, as the same kind of markings is found upon the slabs of stone of which ancient graves have been constructed. It is highly probable that they are a conventional representation of a primitive system of nature-worship that prevailed among our Aryan ancestors, symbolizing the mysterious origin of life. The whole subject has recently been treated in the most able and exhaustive manner by the learned archeologist of the Smithsonian institution, Mr. Charles Rau, in the fifth volume of Major Powell's 'Contributions to American ethnology.' We cannot help feeling surprised that the editor, while quoting largely from Sir James Simpson's 'Archaic sculptures,' makes no reference whatever to the late Professor Edouard Desor of Neuchâtel, whose various writings upon *Les pierres à écuelles* have shed much light upon this obscure subject.

Another strange problem bearing upon this vexed question of early religious symbols is but just touched upon in this volume. We refer to the use from a very remote period, either for emblematic or decorative purposes, of a peculiar form of cross, resembling the Greek letter gamma four times repeated.

This has been called by various names, — the 'digammated cross,' or 'gammadion;' in the middle ages the 'fylfot;' and recently, by Sanscrit scholars, the 'swastica.' M. Burnouf believes that this, also, is a primitive religious symbol of the Aryan races, and that it represents the two pieces of wood which in early times were laid crosswise before the sacrificial altar in order to produce the holy fire, having their ends bent at right angles and fastened in such a way as not to be moved. Where the pieces crossed there was a small hole, in which a third piece of wood was rotated by means of a cord until fire was generated by friction. This sign occurs upon two Roman altars figured in the volume, which have been transferred to the museum at Alnwick from neighboring stations upon the Roman wall, where they had been disinterred. Several references are given to authors who have treated of this emblem, — among them, to Dr. Schliemann, who found it at Hissarlik upon 'whorls' of baked clay; and the statement is made, that it eventually came to have a Christian signification, and is found in the catacombs at Rome in conjunction with the usual Christian symbols. The elaborate study, however, by De Mortillet, entitled *Le signe de la croix avant le christianisme*, is entirely overlooked, in which its occurrence is traced down from the 'terremares' of the age of bronze, in Emilia, in upper Italy.

A unique object represented is an example of the so-called 'chrisma,' the monogram formed by uniting the first two Greek characters of the name Christ, X and P.

This combination had long been in use as an abbreviation of different words, and it is found upon the coinage of various eastern nations. Constantine placed it upon the 'Labarum' as a Christian emblem; and it is often met with upon his coins and those of his immediate successors, and upon terra-cotta lamps found in the catacombs at Rome and elsewhere. Three, at least, of such ancient Christian lamps, have been discovered in England; but the rarity of the present example consists in the fact that it is embossed upon the outside of a little drinking-cup made of red clay. This is of the very uncommon kind of pottery occasionally brought to light in England, which was manufactured by the Romanized Britons at Caistor, in Northamptonshire, the Durobrivae of the Romans. It is used as an ornament in association with a very well executed representation of the coursing of a hare, and it is probably to be referred to about the middle of the fourth century.

Several fine specimens of ancient Roman fictile ware from Pompeii are delineated, as well as those found in Great Britain, among them handsome lamps and facsimiles of the potter's stamps, which are often found impressed upon their under side. Such stamps were also usually placed upon the bottom of the finest kind of table-ware that was manufactured by the Romans, — that called 'Samian ware' from the place of its origin, but of which the best quality was fabricated at Arezzo, and spread by commerce over the whole Roman world. It is of a lustrous coral color, and often has embossed upon the outside, figures of different deities, or of men and animals, especially of those gladiatorial scenes of which the Romans were so fond. These figures were fashioned in moulds, many of which have come down to our own times, and are of a high grade of artistic merit. Frequently, however, the ornamentation consists only of harmonious conventional patterns, or of a scroll-work of leaves and vines of much grace and beauty of design. The potter's stamp sometimes contains the whole name, sometimes only initials, and occasionally it consists merely of some symbol. One figured in the volume is a representation of 'a tiny human foot,' which the editor thinks is "probably a rebus upon the name of the potter, which may have been CRASSIPES." This is rather an unfortunate conjecture, as it was a special whim of some of the potters of Arezzo to have their stamps made in the shape of a human foot. They are found in this form containing a variety of names, as well as no name at all. The writer has in his possession at least twenty different inscriptions of this sort.

It is certainly remarkable that only in England have there been found, it would appear, any specimens of the actual shoes or sandals worn by the Roman soldiers. One such is represented from the ruins of one of the camps that mark the line of the Roman wall. Similar discoveries upon such sites are recorded, and a few of these objects have been found in the bed of the Thames at London. The writer saw several that came to light in London in 1873, in excavating the foundation for a large building in the heart of the 'city.' On that occasion the ditch that surrounded the fortified Roman town was laid bare, formed out of the natural bed of a little brook, and in it these and many other curious relics were found. These ancient Roman shoes are singularly like modern ones in pattern and mode of fabrication; and, in consideration of their wonderful state of preservation, they would seem to justify the cobbler's proverb, 'There's nothing like leather.'

Among the 'medieval remains,' we find figured and described 'a bronze eagle with uplifted head and open mouth.' The bird, however, strongly resembles one represented in *Archaeologia*, vol. 46, pl. 17, that was discovered in the recent excavations at Silchester in 1870. This, the late John Richard Green, in his Making of England, calls "a legionary eagle, hidden away, as it would seem, in some secret recess, and there buried for ages to tell the pathetic tale of the fall of Silchester." In Horsley's Britannia romana, there is also figured a similar bronze eagle discovered in England. It is true, that the Roman eagles that are delineated upon Trajan's Column and upon the Arch of Constantine are represented with expanded wings, and that Montfauçon and recent writers upon classical antiquity, copying him, have stated that they were *invariably* made in this manner. All three of these birds, however, have their wings folded, from which we may infer that the other fashion of representing them may have arisen in part from the exigencies of pictorial art.

We have an example given of one of those singular seals, in the shape of a monkey perched upon a cube, made of a peculiar kind of porcelain, and bearing an inscription in ancient Chinese characters, such as are occasionally found in the bogs in various parts of Ireland. At first they were believed to be of remote antiquity; and it was even supposed that they had been brought into the country by the Phoenicians, since it was asserted that they are not to be found in China at the present time. But this is not the case, as they can now occasionally be procured of the dealers in curiosities in that country. The inscriptions are engraved in an antique character, now only employed for seals, and known as the 'seal character.' Frequently they consist of some poetic quotation like the one given: 'When the water falls, the rocks appear.' Their presence is undoubtedly due to modern commerce, though not of a very recent period. In this particular they resemble the little Chinese bottles used for holding snuff, which are found in ancient Egyptian tombs, one of which is preserved in the museum at Alnwick. They are about two inches in height, and have on one side a flower, and on the other an inscription, which on several specimens reads, 'The flower opens; lo! another year!' This is known to be a quotation from a poet who lived in the eighth century P.C., and the object evidently was intended for a New-Year's gift. Instead of proving, as Rosellini supposed, the existence of a commerce between the two countries in Pharaonic, or at all events in Ptolemaic times, it is now known that they were brought to Egypt in the middle ages by caravans from western China. They are not of exceeding rarity, as Sir Gardner Wilkinson states that he has seen more than twenty of them, found in the tombs at Thebes and other places, and the writer has half a dozen obtained in Cairo.

Unquestionably the most pleasing object delineated in the volume, and one of the glories of the collection, is the well-known 'Rudge cup.' This is a little bronze vessel, about four inches in diameter and three in height, of a simple bowl shape, and adorned in the most tasteful manner with different colored enamels, in the style called *champlevé*. In this, the metallic field is cut away so as to produce cavities, in which is inserted the paste that becomes vitrified upon being subjected to heat. The ornamentation consists of a series of panels made up of four squares of various colors, alternating with compartments containing four crescents of different hues, set back to back. The colors are turquoise and dark blue, beautifully contrasted with a narrow border of pale red, which outlines and separates the several compartments. Around the top runs an inscription which is supposed to contain the names of several localities lying along the line of the Roman wall, but which has thus far proved a puzzle to the interpreters. It was found in the year 1725, at a place called Rudge Coppice, near Froxfield, in Wiltshire, in a well near the site of some Roman ruins. The well was filled with rubbish; and in it were also found four or five human skeletons, some animal bones, and several coins of the lower empire. It is described as merely 'a remarkable relic of the Roman times;' but this would appear to be a very unmeaning designation, when we call to mind the fact that 'relics' of this description are never discovered in Italy. It may be worth the while to give a brief account of the more important specimens of ancient *champlevé* enamelling that have come to light in Europe, and to state what is known or surmised in regard to their probable origin and place of fabrication.

For purposes of comparison, the editor has given an engraving of an enamelled bronze cup, of similar shape and method of manufacture, which was found at Harwood, in Northumberland, and is now in the British museum. He also describes a facsimile cast of a beautiful vessel, known as the 'Bartlow vase,' the original of which was nearly ruined in a fire which took place in the mansion of Lord Maynard, by whom it was discovered in 1832, during excavations made in a series of remarkable flat-topped tumuli situated at Bartlow, in Essex. A plate showing it in all its pristine beauty may be found in *Archaeologia*, vol. 26, pl. 35. It is now in the British museum, where can also be seen a similar vase, discovered at Ambleteuse, near Boulogne. Still another of the same character, found in the western part of France, is preserved at Angoulême. Finally in the *Mémoires de la société des antiquaires du nord*, n.s., 1868, there is represented an exceedingly beautiful specimen of an enamelled bronze cup of the same pattern, discovered in 1867 in a peat-moss at Maltboeck, in the southern part of the peninsula of Jutland, in Denmark.

Beside these vases, enamelled fibulae and horse-trappings have frequently been found in ancient graves, especially in England. Professor Boyd Dawkins, in his Cave-hunting, also gives a plate representing several brooches of this kind, which were discovered during the explorations of the Victoria cave, in Settle, Yorkshire. This was so named on account of its discovery upon the coronation day of Queen Victoria, in 1839; and it is especially interesting as having been a place of refuge of the miserable British fugitives who fled before the sword of the 'conquering Engle.'

The art of enamelling was known to the ancient Egyptians, the Etruscans, and the Greeks; but the last had ceased to make use of it at least two hundred years B.C. By the Romans it was never practised at all; and it is not alluded to by Pliny in his encyclopedic 'Natural history.' The only reference to it to be found in any ancient author occurs in the *Imagines* of Philostratus the elder (lib. i., im. 27). In a description of a picture of a boar-hunt, after enumerating the different colors of the horses ridden by the youthful huntsmen, and saying that the bits were of silver and the housings enriched with gold and various colors, he adds, "They say that the barbarians, who dwell near the ocean, pour these colors upon heated brass, and that they adhere, and become like stone, and preserve the designs made by them." Now, Philostratus was a Greek rhetorician, called from Athens, in the beginning of the third century, to the court of Julia Domna, wife of the emperor Septimius Severus. As this emperor passed considerable time in Britain, where he built, or at any rate repaired, the wall that goes by his name, and died at York, it is by no means improbable that Philostratus gained his knowledge of the processes of enamelling from accounts brought to the court from that region. To the English antiquaries it seems to be established, by the number and the beauty of such objects that have been discovered in their own country, that this was the principal seat of its manufacture; and Mr. John R. Green does not hesitate to call the 'party-colored enamel the peculiar workmanship of Celtic Britain.' But from the fact that the late Abbé Cochet has found precisely similar enamelled objects in his explorations of ancient cemeteries in Normandy, and from the discovery of cups of the same kind upon the soil of France, the antiquaries of that nation maintain that their own countrymen were 'the barbarians that dwelt near the ocean.' *Non nostrum tantas componere lites;* but certainly objects of this character ought never to be styled 'Roman.'

We wish that we had more space at our disposal to direct attention to the many other beautiful objects of antiquity to be found in this fine collection. Henry W. Haynes.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Linear differential equations. — M. G. Floquet, in a paper entitled "*Sur les équations différentielles linéaires à coefficients périodique*," has made an interesting and seemingly important addition to the literature of periodic functions. He considers a homogeneous linear differential equation of the form

$$P(y), = \frac{d^m y}{dx^m} + p_1 \frac{d^{m-1} y}{dx^{m-1}} + p_2 \frac{d^{m-2} y}{dx^{m-2}} + \ldots + p_m y = 0,$$

the coefficients being uniform functions having all the same period, ω, and the general integral being supposed uniform. If the variable be changed by the substitution

$$e^{\frac{2\pi i x}{\omega}} = \xi,$$

the result is a linear transformation of P, in which the coefficients are uniform functions of ξ. From the known expression for its integrals in the region of a singular point, we may, by giving ξ the above value, vary the form of the solutions of $P(y) = 0$. The author prefers, however, to treat the question directly, inasmuch as he is thus enabled to employ many of the results arrived at by M. Fuchs, and as he can use processes identical with those employed by Fuchs in his study of the integrals around a singular point. M. Floquet obtains thus a fundamental system, S, of solutions connected with a certain algebraic equation, $\Delta = 0$, which he calls *the fundamental equation relative to the period* ω; the first member of $\Delta = 0$ is a determinant of degree m with respect to the unknown ε. The elements of the system S constitute as many *groups* as the equation $\Delta = 0$ has distinct roots; and, by applying a process due to M. Hamburger, these groups are divided into *sub-groups* which are mutually independent. The particular conclusions arrived at are as follows. I. Let $\varepsilon_1, \varepsilon_2 \ldots \varepsilon_n$ denote the distinct roots of $\Delta = 0$; let λ_i denote the order parting from which the minors of Δ cease being all zero for $\varepsilon = \varepsilon_i$. 1°. $P = 0$ admits as distinct integrals $\lambda_1 + \lambda_2 + \ldots + \lambda_n$ periodic functions of the second kind, and no more. 2°. There exists a fundamental system of solutions, including, first, $\lambda_1 + \lambda_2 + \ldots + \lambda_n$ periodic functions of the second kind; second, $m - (\lambda_1 + \lambda_2 \ldots + \lambda_n)$ expressions, each having the form of an integral polynomial in x, and having for coefficients periodic functions of the second kind possessing the same multiplier. 3°. The multipliers of the periodic functions which appear in the fundamental system, either as elements or as coefficients in the elements, are equal to the different roots $\varepsilon_1, \varepsilon_2 \ldots \varepsilon_n$ of the fundamental equation. II. In order that $P = 0$ may have m periodic functions of the second kind as distinct integrals, it is necessary and sufficient that each of the roots of $\Delta = 0$ shall annul all the minors of Δ up to those of an order equal to the degree of the multiplicity of each root. In the above, a periodic function of the second kind, with a period ω, means a function defined by relation $F(x + \omega) = \varepsilon F(x)$; ε is the multiplier; and, if $\varepsilon = 1$, the function is said to be periodic of the first kind. — (*Ann. l'école norm. sup.*, Feb.) T. C. [134

PHYSICS.

(Photography.)

The effect of pressure on the gelatine film. — Capt. Abney has shown, that, if pressure is applied to the sensitive surface of the gelatine plates, the same result is obtained as if the plate had been exposed to the light. The editor of the *British journal of photography*, experimenting further, finds that abrasion, such as may be produced by the motion of a glass rod drawn out to a fine rounded point, is necessary to the action, and that mere pressure, such as would be obtained by a carpenter's vise, produces no effect whatever. A stripped film was next placed upon the other one, and the markings made with the rod upon it, with very heavy pressure. On development with pyro, no effect was at first produced; but, by prolonged action, a green fog was created in the adjacent regions of the film, leaving the figures clear on a dark ground. — (*Brit. journ. phot.*, June 15.) W. H. P. [135

Electricity.

Unipolar conductivity. — Hugo Meyer confirms the result previously obtained by him, that the mineral psilomelan possesses the curious property of unipolar conductivity for electricity. He finds, also, that the resistance to a constant current is independent of the duration of the current, and that different specimens of the mineral are radically different in electrical properties: hence the inconsistent results of different observers are admissible. — (*Ann. phys. chem.*, xix. 70.) J. T. [136

A cheap bolometer. — C. Baur describes a thermoscope which consists of thin gold leaves blackened with platinum chloride, and cut so as to combine large surface with low resistance. These are attached to opposite ends of a cylinder which is hollow and open at the ends, and solid in the middle. These leaves are made the arms of a Wheatstone bridge, and prove to be a much more delicate test for radiant heat than the thermopile. The author terms the instrument a radiometer. — (*Ann. phys. chem.*, xix. 12.) J. T. [137

Measurement of the ohm. — J. Fröhlich describes a 'dynamometric' method of measuring the ohm: the secondary coil is balanced on a rigid horizontal arm, suspended bifilarly so that the plane of winding is perpendicular to the meridian; opposite is placed the inducing coil, in which, by an ingenious arrangement of keys, the current is made, shunted, and broken without a spark. The consequent attractions and repulsions are measured by the swinging of the suspended apparatus. From a preliminary experiment, the author is encouraged to consider the method a practical one. — (*Ann. phys. chem.*, xix. 106.) [138

ENGINEERING.

Engines of lake steamers. — One of the steamers of the Western transportation line has engines of the 'compound' type, two low and two high pressure cylinders, of 20 and of 40 inches diameter and of 40 inches stroke. The steam is cut off at 8 inches in the high-pressure cylinder, and the consumption of steam amounts to but 19 pounds per hour and per horse-power. The boat is 256 feet long, 38 feet beam, and 16 feet draught. The engines and boilers weigh about 100 tons. The latter have 100 square feet of grate-surface, and 3,366 square feet of heating-surface. Another vessel, the E. B. Hale, has simple engines, carries 1,600 tons of freight at 14 feet draught, makes about 10 knots an hour on 1,400 pounds of coal. The engines are 36 by 36, and are supplied with steam by one boiler 12 feet in diameter by 18 feet long. — (*Mechanics*, June 23.) R. H. T. [139

Heating by superheated exhaust-steam. — Mr. Levi Hussey has devised a method of heating buildings in winter by the exhaust-steam from engines by first passing it through a superheater in the flue, and there taking up heat which would otherwise be sent up the chimney and wasted. The steam is thus deprived of all moisture, and then heated to so high a temperature that it will heat more thoroughly, and with less obstruction by back-pressure, than saturated and wet steam. Heat is thus obtained without cost, and rendered effective for useful application to a greater extent than has hitherto been possible. — (*Amer. mach.*, July 7.) R. H. T. [140

CHEMISTRY.

(Analytical.)

Electrolysis of bismuth solutions. — Messrs. N. W. Thomas and E. F. Smith find that bismuth may be accurately determined in solution either as sulphate or as citrate by electrolysis. By three bichromate cells all the bismuth was deposited in a compact form in three hours. It was washed, first with water, then with alcohol, dried, and weighed. The reduction goes on equally well in a solution containing an excess of citric acid. — (*Amer. chem. journ.*, v. 114.) C. F. M. [141

Estimation of hardness in water without soap solution. — Instead of the usual method for estimating the hardness of water, O. Hehner prefers titration with standard sulphuric acid and sodic carbonate solutions. He claims that the results obtained with the soap solution are very variable and wholly unreliable. — (*Analyst*, May, 1883.) C. F. M. [142

The presence of copper in cereals. — In an article on this subject, Mr. E. F. Willoughby reviews the instances in which copper has been found in cereals, and he quotes the following results obtained by Dr. V. Galippe: —

		Copper in a kilogram.
Wheat from	Central France	0. 0100 grm.
" "	La Châtre (Indre)	0. 0080 "
" "	Grand Villiers (Oise)	0. 0052 "
" "	Michigan	0. 0070 "
" "	America (Redwinter)	0. 0085 "
" "	California	0. 0050 "
" "	Native Bric	0. 0054 "
" "	America, soft	0. 0108 "
" "	Russia, hard (Taganrog)	0. 0088 "
" "	Algiers, hard	0. 0062 "
Rye		0. 0050 "
Oats		0. 0084 "
Barley		0. 0108 "
Rice		0. 0016 "

— (*Analyst*, May, 1883.) C. F. M. [143

AGRICULTURE.

Preserved milk. — Loew found that a sample of milk which had been sealed up and heated to 101°, and then preserved for eight years, had undergone decided change. The color was brownish, and the taste intensely bitter. The milk-sugar was changed into dextrose and levulose; the caseine and albumen, into peptone. A sediment yielded crystals of tyrosin after boiling with potash. Milk preserved for a year by Scherff's process was found by Vieth considerably altered in taste, but samples kept in a cool cellar for several months appeared unaltered. — (*Bied. centr.-blatt.*, xii. 57.) H. P. A. [144

Calculation of feeding-rations. — In two feeding-experiments with steers, Caldwell and Roberts found that a ration calculated to correspond to that recommended by Wolff for maintenance caused a very decided and steady gain in weight, while a richer ration gave much greater gains than have been obtained by other experimenters from rations calculated to furnish the same amounts of digestible matters. They conclude that "We have not yet sufficient data, from actual feeding-experiments, upon which to base a reliable calculation of the maintenance-ration, or of a ration for the production of a certain effect." — (*Rep. Cornell univ. exp. stat.*, 1882–83, 18.) H. P. A. [145

Determination of proteine. — Trials of Stutzer's method of separating true proteine from other nitrogenous matters failed to give Newbury concordant results in the case of several concentrated fodders, and numerous difficulties in manipulation were experienced. With coarse fodders the results were concordant. — (*Rep. Cornell univ. exp. stat.*, 1882–83, 34.) H. P. A. [146

Determination of phosphoric acid. — Pemberton's method for the volumetric determination of phosphoric acid in fertilizers by titration with a standard solution of ammonium molybdate gave results closely agreeing with gravimetric determinations. Two improvements in the process are described. — (*Rep. Cornell univ. exp. stat.*, 1882–83, 29.) H. P. A. [147

MINERALOGY.

Peculiar crystals of fluorite. — On a hand specimen of fluorite, probably from Zinnwald, Bohemia, F. J. P. Van Calker noticed that there were on all of the small crystals, which were combinations of cube, hexoctahedron, and octahedron, well-defined markings on each cubic face, making a perfect rectangle whose sides were parallel to the intersection of the cube and octahedron. To account for these peculiar markings, which were present on all of the crystals, the author suggested that each crystal might originally have been of a simpler form, around which a subsequent shell of fluorite had been deposited; and a section from a single crystal, cut near and parallel to a cubic face, showed, when examined by transmitted light, a colorless centre, with the rectangular marking appearing as a dotted line, and outside of this another colorless portion completing the crystal. This fully confirmed the author's suggestion of an enclosure of fluorite in fluorite, showing that the crystals were originally of simple form, combinations of cube and octahedron, which had become coated with some pigment, and subsequently another deposit of fluorite had taken place, building up the hexoctahedron planes on all of the solid angles. — (*Zeitschr. krysl.*, vii. 447.) S. L. P. [148

GEOLOGY.

Lithology.

The eruptive rocks of Tryberg, Schwarzwald. — George H. Williams has published for the doctorate degree a valuable petrographical paper on the Tryberg region, the country rocks of which are gneiss, granitite, and granite, cut by dikes of granite, quartz-porphyry, mica-syenite-porphyry, mica-diorite and nepheline-basalt, while porphyrytuff occupies a portion of the Kesselberg area. The granitite is a crystalline granular mixture of felspar, quartz, and biotite, and is regarded as a typical rock of its kind. The quartz-porphyry has a compact, red groundmass porphyritically enclosing quartz and felspar, also biotite, apatite, and magnetite. The mica-syenite-porphyry has a compact, deep reddish-brown groundmass, holding biotite and felspar, as well as some quartz, apatite, and zircon.

The nepheline-basalt shows a compact, greenish-black groundmass, holding crystals and grains of a fresh, nearly colorless olivine. The groundmass is composed of a mixture of augite, little olivine crystals, and magnetite grains cemented by a colorless mass of nephelite and glass. Some reddish-brown biotite was observed, while apatite in little needles occurs abundantly. The paper is accompanied by a plate and map, while the classification followed is that of Prof. Rosenbusch of Heidelberg, with whom Dr. Williams studied. This classification of eruptive rocks is now the prevailing one in Germany, and, on account of the number of Rosenbusch's students connected with the U.S. geological survey and with other institutions, will be soon generally used in America. — (*Neues jahrb. min., beil.*, 1883, ii.) M. E. W. [149

GEOGRAPHY.

(Arctic.)

Danish expeditions in Greenland in 1883. — Dr. Rink, who is now resident in Kristiania, gives some details as to the proposed work for this season. Lieut. G. Holm, assisted by Lieut. Garde, geologist Knutsen, botanist Eberlin (who also acts as surgeon), and a number of Greenlanders, will undertake the exploration of the eastern coast of Greenland in umiaks, in the narrow strip of water between the great stream of drift-ice and the shore, where these boats may be able to accomplish much not practicable for a vessel. They will endeavor to pass the northern extreme reached by Graah, 1828–30, and to penetrate to the interior by some of the deep fiords, thus obtaining some idea of the region between them and the western coast. The other expedition will endeavor to map the unexplored portion of the western coast between 67° and 70° N. lat., and will be commanded by Lieut. Hammer, assisted by Sylow as geologist, and naval Lieut. Larsen. Notice has already been taken of the arrival of these parties in Greenland. — (*Naturen*, Mai, 1883.) W. H. D. [150

(South America.)

The death of Crevaux. — The details of the destruction of this gallant explorer and his party have been obtained from a native interpreter, who was made captive at the time, but finally escaped across the desert to Ankaroinga. The party had arrived at a spot on the right bank of the Pilcomayo, five leagues above the Rio Tigre, where there is a village of Toba Indians called Cuvarocai. After having been assured of a peaceful welcome, the doctor began to distribute presents to the natives, who, at the advice of their chief, rendered covetous by the sight of the valuables in the hands of the party, fell suddenly upon the explorers, and killed those on the shore. Those still in the boats attempted to escape by swimming, and were pursued, and several of them killed in the water. Only two, Haurat and Blanco, being good swimmers, succeeded in reaching the opposite shore, and hiding themselves in the forest. Nothing has been heard of them since. The interpreter was carried off as a prisoner. The bodies were thrown into the water or left where they fell, except that of Dr. Crevaux, which was carried to a neighboring village, where for thirty-six hours the Tobas sang and performed incantations around it, after which it was conveyed to a spot near to and visible from the huts. The Argentine government has sent Col. Sol with two hundred men up the Pilcomayo to punish the assassins, while the geographical society of Buenos Ayres has sent one of its number to search for the two survivors, and report on the whole subject. — W. H. D. [151

Crevaux's voyages in Guiana. — Henri Froidevaux summarizes previous investigations of the rivers of Guiana, and narrates the advances due to Crevaux. He notes that the indigenous population of Guiana is visibly decreasing, and states that Crevaux believed, that, judging by the abundance of village sites and relics on the river-banks now absolutely depopulated, there was formerly an abundant population. — (*Rev. géogr.*, May, 1883.) W. H. D. 152

Notes. — Dr. Güssfeldt has made interesting trigonometrical surveys in the Cordillera, together with observations on glaciers. He will soon take up the region about Aconcagua. —— The English brothers Haspold, with the warmest approbation of the government of the republic, have undertaken a very exact geological, mineralogical, and natural history survey of the different Argentine states. — (*Mitt. geogr. ges. Wien*, xxvi. no. v.) W. H. D. [153

(Africa.)

Number of Jews in Africa. — According to the estimate of Brunialti, the Jews in Africa number 450,000. Gerhard Rohlfs criticises this as much too high, and, by reviewing the estimates of population in all parts of the continent, concludes that 220,000 is much nearer the truth. — (*Peterm. geogr. mitth.*, 1883, 211.) W. M. D. [154

The coast-line of Tunis. — In his description of the Mediterranean lands, Th. Fischer has included Tunis in the area of rising coasts about Sicily, Sardinia, and south-eastern France. The correctness of this is questioned by Dr. J. Partsch of Breslau, who presents a considerable mass of evidence to show that the Tunisian shores have not changed their altitude in the historic period, although their outline has varied distinctly at certain points by delta growth. The river Medjerda (the ancient Bagradas) has shifted its mouth several miles to the north, and built out its delta into the Gulf of Tunis; and this in combination with the wind-action, by which sand has been blown inland from the shore, has added nearly one hundred square miles of lowland outside of the coast-line of the third century before Christ. Former lines of river-flow are distinctly visible at several points. But all this, and other facts of a similar nature, must not be explained by an elevation of the land; for the ruins of Carthage, on a promontory a few miles to the south, are still close to the sea, and the remains of some of its harbor-works are yet at the water's edge. A variety of ancient and modern descriptions of this region are referred to. — (*Peterm. geogr. mitth.*, 1883, 201, map.) W. M. D. [155

ZOÖLOGY.

Protozoa.

New sporozoon. — A. Schneider has discovered in the Malpighian vessels of Blaps an amoeboid parasite. Multiplication takes place principally by means of cysts. Encystment occurs only between individuals with a single nucleus and of spherical form. The two conjugated organisms secrete around themselves several envelopes, each marked with an equatorial line of dehiscence. Each of the two nuclei divide into three. Of the six nuclei thus formed, four, together with a part of the granular mass, remain unused, while the other two become the spores. The species is named Ophryocystis Bütschlii. — (*Comptes rendus*, 1883, 1378; *Ann. mag. nat. hist.*, xi. 459.) C. S. M. [156

Insects.

Observations on Hymenoptera. — In part x. of his Observations, Lubbock answers some of Dr. Müller's objections to his methods in studying the color-preferences of the hive-bee, believing that his conclusions are not invalidated by them. To test the sense of hearing in bees, telephonic communication was established between two sets of bees, one of which was then excited, but with no effect on the other. Others were accustomed to visit honey placed near a music-box, the position of which was several times changed. The bees did not, however, appear to hear the music, though they seem to have connected the presence of the instrument with that of the honey, and were guided by it, even if it were not playing, so long as they could see it; but if they could not see it, even if it were playing, it did not assist them. It is, however, uncertain but that high over-tones, beyond our range of hearing, may be audible to bees.

Further experiments seem to show that the industry of wasps has been underrated. One individual visited some honey no less than a hundred and sixteen times in a day, loading herself each time, and carrying away more than sixty-four grains of honey. Her working-hours extended from 4.13 A.M. to 7.47 P.M., while a bee, working on honey the same day, made but twenty-nine visits, between 5.45 A.M. and 7.15 P.M.

A curious demonstration of the recognition of the queen by worker-ants was made in the following way: "I was starting a new nest of Lasius flavus in which were two queens. We allowed the ants to take one of them into their new glass house; the other we kept with a small retinue in a separate bottle. If this bottle is placed near the nest, some of the retinue leave it, go into the nest, and soon the ants come out in large numbers to see, I had almost said to pay their respects to, their queen."

The dislike of ants for the ultra-violet rays of the spectrum, indicated by earlier experiments, was further shown by the use of two screens, — one consisting of a solution of iodine in carbon bisulphide; the other of indigo, carmine, and roseine, mixed so as to produce the same tint, but not, like the bisulphide solution, intercepting the ultra-violet rays. The ants collected, in most instances, under the iodine screen.

The record of the occurrence of Ponera contracta in England, and the description of a new Australian honey-ant, Melophorus Bagoti, are of interest to the systematist. — (*Journ. Linn. soc., zoöl.*, xvii.) W. T. [157

(Economic entomology.)

Insects affecting the strawberry. — Professor S. A. Forbes summarizes what has been published respecting the insects that infest the strawberry in the United States, and adds original observations respecting several of them. These observations refer chiefly to the crown-borer, the root-worm, and the crown-miner. A very useful calendar is given, indicating in a concise form the periods of each of the species discussed and the particular place in which each insect occurs in each of its stages. — (*Trans. Miss. Valley hort. soc.*, 1883.) J. H. C. [158

The hop-vine borer. — Although this pest has been very destructive for many years, the life-history of the species has not been known till now. Prof. Comstock gives an account, with figures, of the insect in each of its stages. — (*Amer. agric.*, June, 1883.) [159

VERTEBRATES.

Are the lungs air-tight? — That the lungs are normally air-tight under the ordinary condition of life has been accepted in physiology as an almost necessary consequence of the function which they perform. Ewald and Kobert have lately reported some experiments which appear to show that this belief is not strictly correct. If the intra-pulmonic pressure is raised above a certain limit, not higher than may occur normally during life, there is an escape of air from the lungs into the pleural cavity or into the blood-vessels of the pulmonary circulation. When a curarized dog was exposed to artificial respiration at a proportionally high pressure for about an hour, the dog killed, and the chest opened under water, both the pleural cavity and the heart were found to contain air. Experiments made upon excised lungs, expanded under water by positive pressure, showed, that, at a certain pressure, air escaped, while, if the pressure was again lowered, the lungs again became air-tight. The authors satisfied themselves in all cases that there was no actual gross rupture of the lung-tissue or blood-vessels. The maximal expiratory pressure which a dog can produce was found to vary between 50 mms. and 90 mms. of mercury; while, to get an escape of air into the pleural cavity or heart, it was only necessary to keep the intra-pulmonic pressure at about 35 mms. of mercury. A similar result was obtained with rabbits. The escape of air may take place not only through the walls of the alveoli, but also through the trachea, with the production of emphyaema of the subcutaneous cellular tissue of the neck, which in time may spread as far as the extremities of the body. The peculiar pains in the chest which sometimes follow upon violent expiratory efforts may be owing, they think, to a small escape of air into the pleural cavity. So many hitherto inexplicable cases in which, after sudden death, air has been found in the heart or pleural cavity, although there was no evidence of any rupture, may be explained in this way by the escape of air through the lung-tissue. — (*Pflüger's archiv*, xxxi. 160.) W. H. H. [160

Structureless basal substance. — The structureless substance which forms the basis of the 'jelly' in medusae, Emery thinks, is still represented in the higher animals, preceding in certain places the true connective tissue. Emery employs the name given by Hensen, 'tissue of secretion,' it being supposed to be secreted by the surrounding epithelia. In vertebrates an anhistic layer in the cornea precedes the true connective tissue (Kessler, Emery). In the embryos of teleosts, particularly those that leave the egg early, the ectoderm is separated by a thick layer of homogeneous, unorganized matter from the inner tissues. This hyaline mass also fills out the embryonic median fins. It is probably changed later into connective tissue by the immigration of cells. The clear membranes separating two adjacent epithelia, or an epithelium from connective tissue, the vitreous humor, and the substance filling the segmentation cavity of the ovum, are also, perhaps, to be enumerated here as preservations of a very ancient primitive formation, — the tissue of secretion of the most distant ancestors of vertebrates. Its excessive development in teleost larvae is probably an acquired embryonic characteristic. This interesting little paper especially deserves attention from those studying the embryology of fishes. — (*Arch. ital. biol.*, iii. 37.) C. S. M. [161

Fish.

Motor-nerve endings. — Ciaccio has investigated the motor-nerve plates in the depressor muscle of the jaw of Torpedo marmorata by treatment with double chloride of gold and cadmium. From the anterior third of the muscles, strips one millimetre thick were cut with scissors; the strips were then left for five minutes in fresh filtered lemon-juice, washed in distilled water, and placed for half an hour in a one-per-cent solution of gold and cadmium, being kept dark; washed again in one-per-cent aqueous solution of formic acid, in which they were left twelve hours in the dark, then twelve in the light; finally, kept in the dark in stronger formic acid for one day, and preserved in glycerine. Such strips may be easily dissociated into fibres.

Two forms of nerve-endings are observed. One, the rarer, represents probably the initial form: it consists of bunches of grains, suspended by peduncles arising by repeated division of the pale fibres towards their termination. The second form has been previously described (*Mem. accad. sc. istit. Bologna*, 1877), but the following new points deserve mention: the end-plate appears to be more closely united to the sarcolemma than to the muscular substance; between the ramifications of the fibres appear certain corpuscles, probably connective tissue, but whether they lie within or without the sarcolemma was not determined; a secondary sheath extends over the primary and secondary, but stops at the tertiary branches; the ultimate terminations are bunches of pedunculated grains, the grains being colored dark, their stalks light; finally, the presence of a granular embedding substance around the nervous branches. — (*Arch. ital. biol.*, iii. 75.) C. S. M. [162

Fishes of the Batstoe River, New Jersey. — Professor E. D. Cope stated that eleven species collected in the confined waters of a broken dam on the Batstoe River, New Jersey, represented the fish fauna of the Carolinian district of the nearctic realm, only three extending into the Alleghanian district. A species of Amiurus new to science was at first supposed to be an unusually dark-colored example of the common Amiurus nebulosus. A critical examination soon showed that it differs in the important characters of the considerably more anterior position of the dorsal fin, four to seven more anal radii, and more rounded outline of the caudal fin. Its characters ally it to the western A. natalis, from which it differs by its more slender form and more rounded caudal fin. The name A. prosthistius was proposed for it. — (*Acad. nat. sc. Philad.; meeting* June 26.) [163

Mammals.

Color-markings of mammals. — Professor Eimer has continued his studies in regard to the color-markings of vertebrates.

As the result of his observations, he has drawn out certain general principles, which he applies to the different groups, notably to the mammals.

The following general statements are elaborated: 1. That the color-markings of mammals may be reduced to longitudinal stripes, spots, and transverse stripes; 2. That the longitudinal stripes are the oldest form, and that the other two follow in course; 3. That the primitive mammalian fauna was a longitudinally striped one; 4. That the males have been first to take on the new forms of markings, while the females hold longer to the older form; 5. That the effects of the law by which the development of the markings takes place from the posterior part of the body toward the anterior part are not so easily traced in mammals as in the case of other groups, such as the saurians; 6. That in mammals the development of markings follows a regular course, that is, the longitudinal markings are followed by spots, which, in turn, run together, and finally form the transverse or tiger stripes; 7. That the position of the smallest spot on a mammal is not accidental, but due to the action of genetic and philogenetic laws, from which it follows that markings are an available means for the determination of species; 8. That the regularity of the development of markings shows that they arise from constitutional causes.

The author takes the Viverridae as the original types of the carnivores, and believes that in the hyena, cats, dogs, bears, and weasels, he can trace the form and position of markings possessed by the former. He acknowledges several difficulties, however, in the case of the leopard, jaguar, and other peculiarly spotted cats. He believes that the ungulates follow the same law in regard to markings as the carnivores. — (*Jahresb. verein vaterl. naturk. Württ.*, xxxix. 1883. 56.) F. W. T. [164

(*Man.*)

Function of the crico-thyroid muscle. — Martel brings forward some experiments to show that the crico-thyroid, and not the thyro-arytenoid muscle is par excellence the muscle used in the production of different tones in singing and speaking. The most interesting point of the paper, perhaps, is, that he shows, by registering with simple levers the movements of the thyroid and cricoid cartilages respectively, that, when the different chest-notes (from do^2 to do^4) are sounded, the thyroid cartilage remains immovable, while the cricoid is brought closer and closer to it as the pitch of the note is raised. In the contraction of the crico-thyroid muscle, or, as he prefers to call it, the thyro-cricoid muscle, the thyroid cartilage is therefore to be considered as the fixed point. The action of the thyro-arytenoid muscle, according to him, is preparatory to that of the crico-thyroid, in that it gives the vocal cords their proper position, and acts as an antagonist to the latter muscle. The length and tension of the vocal cords, however, are governed by the crico-thyroid. This view of the function of the crico-thyroid is supported by the results obtained when the muscle, or the nerve going to it, is divided in the dog, and, among men, by the pathological cases in which there is paralysis of this muscle. The general result in such cases is a pronounced hoarseness, and an inability to sound any but the lowest tones. — (*Arch. de physiol.*, 1883, 582.) W. H. H. [165

Summation of stimuli in the sensory nerves of man. — From numerous experiments made upon himself with electrical stimuli, de Watteville comes to the conclusion that the action of stimuli applied to a sensory nerve increases, within certain limits, with their frequency. Stimuli which are subminimal, as long as they follow at slow intervals, will call forth a sensation when made to follow each other with greater rapidity. This summation takes place more readily when the stimulated nerve is exposed to the action of the kathode; and the author is of the opinion that it is local, as in motor nerves, and not central. The summation may be explained as the after action of electrical stimulation; the induction shocks following with such rapidity that the excitation in each case falls within the period of heightened irritability. — (*Neurol. centralbl*, no. 7, 1883.) W. H. H. [166

ANTHROPOLOGY.

Tribute to American scholarship. — An interesting tribute to American scholarship is paid in the fact that M. Barbier, on the authority of Mr. Stephens and later writers, was setting up Del Rio's 'images of men in bas-relief' in front of the model of the Temple of the Sun, as he had done in the Trocadero. Dr. Rau of the Smithsonian institution drew his attention to Del Rio's description of the Temple of the Cross, as well as to the statements of Dupaix and Galindo; and the bas-reliefs at Washington will stand in their proper place in front of the shrine containing the group of the Cross. Again, Prof. Cyrus Thomas has discovered that the cast on the left slab of the Tablet of the Cross proves conclusively the correctness of the statement previously made in SCIENCE, that Waldeck's figure of this slab, as published by the French scientific commission, 1860–66, was copied from Catherwood's drawing. This is proved by the fact that Catherwood's errors, of which M. Charnay's cast brings to view quite a number, are all faithfully reproduced in Waldeck. — O. T. M. [167

Prehistoric trepanning. — The object of recalling attention to this much described subject is to speak of the novel experiments of L. Capitan. Many years ago Dr. Charles Rau, wishing to know how long it would take a savage to bore a hole through a hard rock with a wooden spindle, using sand and water, actually made the experiment, and has put on record his experience. M. Capitan has proceeded in the same way respecting prehistoric trephining, testing the various methods of boring and of removing a rondelle or fragment of bone. The experiments on the skulls of the dead were to study the methods, the difficulties in the way of the operation, and the time required. It is the trephining of the living among savages, and the fatality of the result, that most interest the student: therefore M. Capitan continued his researches upon living canine subjects. The first experiment was upon a small spaniel. The skin of the head and temporal muscle were removed, and the trephining was practised upon the antero-superior portion of the right parietal. The operation was not very painful, and in twenty minutes a rondelle of bone was removed. There was little hemorrhage and the meninges were not wounded. After a few days the spaniel was as lively as ever. Two other dogs were subsequently treated, with like success. Just what the method and amount of cicatrization might be, after such primitive operations, will be known when the autopsy of the subjects takes place in the future. — (*Bull. soc. anthrop. Paris*, v. 535.) J. W. P. [168

Catlinite. — The beautiful red stone pipes in collections of Indian culture-objects are made of a stone called catlinite. Mr. E. A. Barber tells us that for many generations the aborigines have procured this material from the Great red pipestone quarry, situated on the dividing-ridge between the Minnesota and Missouri rivers, at a place called by the French *Couteau des prairies*. Catlin, the celebrated traveller, was the first white man permitted by the Indians to visit the place; and therefore Dr. C. T. Jackson, to whom specimens were sent, named the mineral catlinite. The myths relating to the quarry, as well as surface indications, show that the place has been worked for a very long time. In 1673 Marquette smoked in peace a catlinite pipe with the Indians of the upper Mississippi. Father Hennepin applies the term 'calumet' to these ceremonial pipes. There is no doubt that an extensive traffic was carried on in this material for a considerable length of time by the aboriginal tribes, extending from the Atlantic coast to the Rocky Mountain system and from New York and Minnesota on the north to the Gulf of Mexico. The fact that objects of catlinite have been taken from Indian graves in the state of New York, and that others were found on the ancient site of an abandoned village in Georgia, at opposite points twelve hundred miles distant from the pipestone quarry of Minnesota, reveals the great extent of intercommunication which formerly existed among the North American peoples. When we consider that many pipes of catlinite have been taken from the bottom of mounds from four to seven feet deep, where they were found in connection with cloth-wrapped copper axes and many other objects of high antiquity, and that some of them are of the typical form of the oldest mound-pipes, we are forced to ascribe to some of them a high antiquity. — (*Amer. nat.*, July.) J. W. P. [169

The Charnay collection. — Visitors to the National museum at Washington are surprised to find the great hall adjoining the last doorway on the south side shut off by screens. Looking behind this barricade, the visitor may imagine himself transported to Central America, and in the presence of some of her grandest aboriginal remains. Here M. Barbier, from the Trocadero museum at Paris, is setting up casts of the most celebrated relics of Mexican and Central American ruins secured by M. Charnay. The readers of SCIENCE will recall that Mr. Pierre Lorillard of New York, conjointly with the French government, equipped an expedition in 1880, and maintained it for two years, for a systematic investigation of the so-called 'ruined cities' and other remains of ancient civilization in Central America and Mxeico. The expedition was placed under the charge of M. Désiré Charnay, and thoroughly furnished with the means of making photographs and casts by the process of M. Lotin de Laval. Copies of these casts were first to be presented to the Smithsonian institution and to the French government, the latter set to be placed in the Trocadero museum at Paris. The story of M. Charnay's travels and successes has been told in the *North American review*, commencing with August, 1880; the editor, Mr. Thorndike Rice, favoring and encouraging the expedition from the first. M. Charnay's moulds having been transported to Paris, he proceeded to make his reproductions. With reference to the Smithsonian series, now being set up in the National museum, Mr. Rice writes, "These casts are duplicates of those now on permanent exhibition at the Trocadero, Paris. The casts have been made in order to afford to students of American antiquities the fullest opportunity for studying these products of indigenous art and the hitherto indecipherable inscriptions." The collection includes a bas-relief from Ocosingo, the stone of Tizoc, fragment from Tezcuco, thirty-eight pieces from Palenque, including the most celebrated sculptures and inscriptions, and thirty-four pieces from Chichen-Itza. M. Hamy will shortly send a detailed account of each piece, and the readers of SCIENCE will receive the benefit of his information. Professor Baird will have the bas-reliefs of the Temple of the Sun and those of the Temple of the Cross mounted in wooden frames, the exact reproduction of the rooms which they occupied in Palenque. — J. W. P. [170

EARLY INSTITUTIONS.

The Nottingham records. — The records of the borough of Nottingham have been published by Quaritch in London. They cover the period from 1155 to 1399, and contain much interesting matter bearing upon the history of town customs and government in England. Mr. G. L. Gomme, the author of Primitive folk-moots, reviews the volume, and gives us some extracts from it. Assuming that the municipal corporation of the thirteenth century is the primitive village community in a late stage of development, he discovers various customs which he describes as belonging to the primitive village. The history of the primitive village is in this way extended and enlarged. Some very interesting passages, illustrative of the right of pre-emption which kinsmen enjoyed, are given. It appears, that, "if a person sold his land [in Nottingham], his nearest heirs might lawfully enter into such lands and tenements if they offered to the purchaser, in the gild hall of the town, the money which he had given for the property." Some passages bearing upon the history of the open-field system are also cited. Mr. Gomme regards the open-field system as 'the best evidence of the old primitive tenure of land.' The custom of borough English — or 'junior-right,' as Mr. Elton calls it — obtained at Nottingham. — (*The antiquary*, April, 1883.) D. W. R. [171

NOTES AND NEWS.

It is hoped that the new section for mechanics of the American association for the advancement of science will receive the earnest co-operation of all interested, who may find it convenient to attend. The approaching meeting at Minneapolis will be the second held by the section. Those having matters of interest to present are requested to notify the secretary of section D (A. A. A. S.) at Minneapolis as early as possible. Circulars relating to the meeting may be obtained of the permanent secretary of the association, F. W. Putnam, at Minneapolis.

— During the coming year, experiments will be made at the physical laboratory of Johns Hopkins university with a view to aid in establishing an international unit of electrical resistance. The experiments will be carried on, under the direction of Professor Rowland, with an appropriation from the government of the United States. The results will be communicated to the International commission of electricians, meeting in Paris.

— We alluded a few weeks ago to the award of the first Walker prize of the Boston society of natural history to Mr. Howard Ayres of Fort Smith, Ark., for his memoir on the development of Oecanthus. This memoir is now printing by the society. The award of the second prize has now been made. Several papers of unquestionable merit were before the committee, and the subjects were so diverse as to make it difficult to decide between them. Expert aid was sought; and it has been at last concluded to divide it equally between William Patten of Watertown, Mass., who offered an essay on the development of Phryganidae, and H. W. Conn of Johns Hopkins university, who presented an essay on the life-history of Thalassema millita.

— Recognizing the demand for thoroughly trained engineers conversant with electrical science, at the beginning of the next academic year (Sept. 18, 1883) the trustees of Cornell university will receive students who desire to fit themselves to enter this new and constantly extending field. While the general studies are mainly those of the departments of civil and mechanical engineering, the special studies of the course embrace the theory of electricity, the construction and testing of telegraph lines, cables, and instruments, and of dynamo machines, and the methods of electrical measurement, electrical lighting, and the electrical transmission of power.

— During the past year original investigations, the results of which either have been or soon will be published, have been made in the biological laboratory of Johns Hopkins university, in the following subjects: the direct action upon the heart of ethyl alcohol, the influence of digitaline upon the heart and blood-vessels, the influence of quinine upon the blood-vessels, the influence of variations in arterial pressure upon the time occupied by the systole of the heart, the minute structure of the kidney, the life-history of Penicillium, viscous fermentation, the influence of various illuminations on the growth of yeast, the structure of Porpita, the structure of the gasteropod gill, the development of the mammary gland, the structure and properties of the cavernous tissue beneath the olfactory mucous membrane.

— The U. S. geological survey has appointed Prof. H. S. Williams of Cornell university upon its staff. Under its auspices he will carry out more fully the studies he has long undertaken upon the upper Devonian fossils of the rich localities of his neighborhood in New York, and extend the work beyond the limits of the state, as well as into the immediately underlying and overlying strata, for better comparison of the upper Devonian species, and study of their faunal relations. Professor Williams has been endeavoring to build up a thorough school of comparative paleontology at Cornell with good success; and the assistance he will gain from his connection with the U.S. survey will offer a special attraction to those wishing to pursue paleontological studies under him. Mr. C. S. Prosser, a recent graduate of Cornell, assists him this summer in his geological work in connection with the U. S. survey.

— A very interesting sketch of the life of Count Rumford, by Professor Tyndall, is printed in the *Contemporary review* for July. An account of his scientific labors is promised in a future issue.

— W. H. M. Christie, F.R.S., astronomer royal, has withdrawn from the editorship of *The observatory*, a monthly review of astronomy. This periodical will now be edited by E. W. Maunder, F.R.A.S.; and all communications should be addressed to him at the Royal observatory, Greenwich, as formerly.

— Dr. M. Braun in Dorpat proposes a zoölogical investigation of the Gulf of Finland. The Russian government will furnish a steamer, and the explorations are to be made on behalf of the Naturalists' society of Dorpat.

— The *American apiculturist* is the ninth periodical in the United States devoted to bees and apiculture. Several of these papers have a circulation numbering thousands, and one is a weekly. It would seem rash to start another bee paper under these circumstances. Silas M. Locke, editor of this new journal, seems, however, to have counted the cost, and means to act on the principle that there is always room up higher. He is an experienced bee-keeper, and expert in all the manipulations of the apiary. He has paid special attention to the qualities of the several races of bees, and is alive to the importance of great care in breeding bees, if the apiarist would secure the highest success. It is evident that he intends to give special attention to matters of scientific interest connected with bees and bee-culture.

Mr. Locke has also secured the assistance of the ablest writers on the apiary in the country, — not men who are simply given to fine writing, but practical men, who have won eminent success in the art which they practise. The paper is published at Salem, Mass., and, in typography and general style, has no superior among our apiarian periodicals.

— According to *Nature*, the report of the sanitary commissioner with the government of Bombay shows, that, among other causes of death in that presidency in the year 1881, 1,209 persons died from snake-bite. A comparison of the deaths in 1881 with the mean of those of five preceding years shows, that, in 1881 at least, the number had increased. These figures prove that one person in 13,610 of the whole population of the twenty-four presidency districts died from snake-bite. Adding to this the destruction of human life effected by other venomous and carnivorous animals, we see how important a matter to the residents of those regions is the destruction of this unfavorable environment.

— All the readers of SCIENCE have been familiar with the word 'wampum' from their childhood. Roger Williams wrote in his Key, "The New-England Indians are ignorant of Europe's coyne. Their owne is of two sorts, — one white, which they make of the stem or stock of the periwincle, which they call meteauhok when all the shell is broken off. This they call *wampam* (white). The second is black, inclining to blue, which is made of the shell of a fish which some English call hens (poquahock)." This money was called suckauhock (*sucki*, black). Various shells were used in different parts of the country under names adopted from the languages of the tribes who coined the money. But in the history of the early colonies the name 'wampum' has gained a footing for all shell-money as well as for its imitations. Mr. Earnest Ingersoll has brought together a large amount of information on the subject in the May *Naturalist*.

— The death is announced of E. Mohler, secretary of the Danube commission, and of Hermann Alexander von Berlepsch of Zurich, the latter in his seventy-first year.

— The death is also announced of Dr. J. S. Bailey of Albany, a young entomologist who had published a few papers of some importance on Lepidoptera.

— In the June number of the *Journal of science* is given the following account of a bird-eating frog. "A lady living in the George district (Cape Colony) supplies the *G. R. herald* with the following particulars of the remarkable habits of this creature: 'I have much pleasure in furnishing all the information we have, regarding the large frogs which have proved so destructive to our young chickens. A water-sluit runs round our terrace, and passes through the ground over which the poultry range, and in this the frogs harbor. The first time our attention was drawn to their bird-eating propensity was by the cries of a small bird in a fuchsia near the stream. Thinking it had been seized by a snake, several hastened to the spot, and saw a beautiful red and green sugar-bird in the mouth of a large greenish frog. Only the bird's head was visible; and, its cries becoming fainter, the frog was killed, and the bird released. Its feathers were all wet and slimy, and for some days after we could distinguish it in the garden by its ruffled plumage. Since then the same species of frog has on several occasions been killed with young chickens, half-swallowed; and once a duckling was rescued from the same fate. Whether the noise is natural to these frogs, or assumed to decoy the chickens within their reach, we know not; but they constantly make a chuckling sound so exactly like a hen calling her chickens for food that we have seen whole broods deceived, and rushing towards the sluit, where they supposed the hen to be. The frogs are very wary, and it is difficult to find them unless by the screams of their victims. We have lost large numbers of small chickens in an unaccountable manner, and feel sure now that these frogs must be answerable for very many of them, as there are no rats here, and the chickens are carefully housed at night. If I can give you any further details, I shall be glad to do so.'"

— The distinguished spectroscopist, M. Thollon, is now working at the observatory at Paris, as has been his custom during previous summers. The proposed observatory on the top of the Pic du Midi — where the brothers Henry saw the planet Venus with the naked eye in full daylight, when only three or four degrees from the sun, and two days after the transit — is said to be making great progress toward completion. It is expected that Admiral Mouchez, M. Thollon, and other astronomers will visit it toward the end of August.

— The *Vierteljahrsschrift der astronomischen gesellschaft* (18 jahrgang, erstes heft) is frontispieced with a solar print of Dr. Carl Christian Bruhns, the late director of the observatory at Leipzig. In the *nekrologe* are brief notices of Bruhns and C. Baeker, and a more extended one of E. Plantamour, by Dr. Rudolph Wolf of Zurich. Among the *literarische anzeigen* are the following: Backlund, Zur theorie des Encke'schen cometen, by Paul Harzer; Callandrean, Détermination des perturbations d'une petite planète par les méthodes de M. Gyldén, by O. Backlund; Ginzel, Astronomische untersuchungen über finsternisse, by Th. von Oppolzer; and Fischer, Der einfluss der lateralrefraction auf das messen von horizontal-winkeln, by Wilhelm Schur. Among the newly elected members of the *gesellschaft* are P. Harzer of Leipzig, J. Holetschek of Vienna, J. Scheiner of Bonn, and C. Wagner of Kremsmünster. The next meeting of the *gesellschaft* will be held at Vienna, commencing on Friday, Sept. 14, and lasting four days.

— The geological commission of Spain has prepared a pamphlet of twenty pages for the mineral exhibition, now open at Madrid, giving a brief account of the different geological formations occurring in Spain, their geographical distribution, general characters, and the minerals of economic interest occurring in each. It also gives a short orographical account of the country, which has a higher average elevation than any country in Europe excepting Switzerland. The highest peak is that of Mulahacen, in the Sierra Nevada, 3,554 metres above the sea-level. The formation which has the greatest extent in Spain is the tertiary, which covers 34 per cent of the surface; next comes the primary, covering 27 per cent; the secondary, 18½ per cent; the hipogenica, 10 per cent; the quaternary, 10 per cent; and the azoic, ½ per cent. Given in numerical order, the miocene and oligocene cover together 137,877 □ kilom.; the Cambrian and Silurian, 114,382; the hipogenica, 49,665; the quaternary, 49,477; the cretaceous, 47,002; the eocene, 23,564; the Jurassic, 22,697; the triassic, 22,443; the carboniferous, 11,301; the pliocene, 9,064; the Devonian, 5,780; and the crystalline strata, 1,694, — a total of 494,946 □ kilom. The term '*rocas hipogenicas*' is applied to what are generally called plutonic and volcanic rocks, both old and recent eruptive rocks.

— Père Vidal, French missionary at Tutuila, Navigator's Islands, announces the discovery, made last year, of the place of burial of Commandant Fleuriot de Langle, of the unfortunate expedition of la Perouse. De Langle and his companions were killed by the natives at a point named Massacre Bay, in December, 1787; but up to this recent date their remains and place of burial had not been discovered. The pious missionary intends to erect an expiatory chapel for the converted natives on the spot where their barbarous ancestors' victims were buried.

— Mr. Henry H. Howorth, who is our standard authority on the Mongols, reviews with favor the work of the Rev. James Gilmour, who has lived as a missionary among them. We have space only for a brief abstract upon the hospitality of these least sophisticated tribes of men: "Any traveller is at perfect liberty to alight at any village he may wish, and demand admittance; and any Mongol who refuses admittance, or gives a cold welcome even, is at once stigmatized as not a man, but a dog. Any host who did not offer tea without money and without price would soon earn the same reputation; the reason being, I suppose, that Mongolia has no inns, and all travellers are dependent on private houses for shelter and refreshment. At first sight it seems rather exacting to leap off your horse at the door of a perfect stranger, and expect to find tea prepared and offered to you free; but probably the master of the tent where you refresh yourself is at the same time sitting likewise, refreshing himself in some other man's tent some hundred miles away; and thus the thing balances itself. The hospitality received by Mongols in travelling compensates for the hospitality shown to travellers."

— Two noteworthy ornithological papers appear in the August magazines. The habits and mental traits of the cat-bird in confinement have found an excellent student in Olive Miller, who gives us in the *Atlantic* a vivid picture of its curiosity, and its tyranny over weaker birds, with proofs of how it can learn by experience, and its capacity for jealousy. The article is well worth reading.

The friends of Prof. A. M. Meyer of Hoboken, who are aware of his zeal as a sportsman, will be less surprised than those who know him only by his professional studies, at his interesting paper on the quail, or 'Bob White' as it is familiarly known, which appears as the leading paper in the midsummer *Century*. Eight or nine exquisite woodcuts by Beard illustrate the different species of this class of game-birds in Europe and America, and far surpass in finish, and in excellence of delineation, any previous pictures we have seen.

— An increased interest in economic entomology is being shown in England. The Council of education (My lords of the privy council) have formed a committee of advice and reference regarding the entomological collections which have existed for some time in connection with South Kensington museum. This committee is under Professor Huxley as chairman; and among the members are Professor Westwood, Mr. Dyer (sub-director at Kew gardens), and Miss Ormerod. It is planned to form a collection of cases that shall show the insects commonly injurious to a serious extent to the crops, fruit and timber trees, of the British Isles. Each case is to be accompanied by short life-histories of the species in it, and descriptions of the most serviceable methods of preventing their ravages. It is the purpose of the committee to make the collection thoroughly plain to be understood, so that farmers and gardeners may be able to consult it serviceably. As far as possible, the insects will be shown in all stages, together with specimens of the injured plant. In those cases where specimens are too small or too perishable to be used, drawings or models will be substituted. The carrying-out of this plan in a thoroughly scientific manner has been assured by placing the preparation of the cases in the hands of Professor Westwood and Miss Ormerod.

— In order to bring together the greatest amount of solid information respecting the natural history of man, students have published manuals of anthropology from time to time, formulating the questions they desire to have answered. In 1800 Degeraudo, a member of the Institut de France, published a quarto of fifty-seven pages, entitled 'Considérations sur les diverses méthodes à suivre dans l'observation des peuples sauvage.' The Société ethnologique de Paris, in 1839, published its first memoir, which was preceded by general instructions addressed to travellers, among which were three chapters on the individual, family, social, and religious life of peoples. Mr. Gallatin, in our own country, while preparing his comparative Indian linguistics, issued circulars to all army officers, Indian agents, and travellers. Mr. Schoolcraft prepared a very elaborate scheme. George Gibbs published through the Smithsonian institution a linguistic circular, and the same institution has issued a number of others on anthropological subjects. The most elaborate published in our country are Major Powell's manual for collectors of linguistics, and Professor Mason's directions to collectors for the Centennial exhibition, and his pamphlet on the study of North American antiquities. In 1875 the Geographical society of Paris published 'Instructions aux voyageurs.' The British association have printed three sets of questions, in 1851, 1854, and in 1874. The last named bears the title 'Notes and queries on anthropology for the use of travellers and residents in uncivilized lands.' The Austrian expedition in the frigate Novara was furnished with a very elaborate volume of questions upon anthropology. In addition to these, we have 'Instructions anthropologiques' and 'Instructions craniologiques' by the Paris society, and manuals by Roberts and Kaltbrunner. Finally, the last-named society has been discussing with much learning and a slight loss of temper a 'Questionnaire de sociologie et d'ethnographie.'

— The following investigations have been completed by advanced students at the chemical laboratory of Johns Hopkins university during the past year: on the conduct of moist phosphorus and air towards carbon monoxide; white phosphorus; oxidation of a compound containing the sulphamine and propyl groups in the ortho-position with reference to each other, showing protection of the propyl; oxidation of paradipropylbenzine-sulphamide, showing protection of the propyl; on the nature of sinapic acid; the influence of light on fermentation; chemical examination of minerals from the neighborhood of Jones's Falls.

— Regarding the early telescopic observations of the ring of Saturn, Dr. H. G. van de Sande Bakhuyzen, the director of the observatory at Leiden, writes to the editor of *The observatory:* It is clear that Bell is not the discoverer of the division of Saturn's ring: but that Cassini ought to be accounted the discoverer is not quite so certain. In a volume of MS. observations by Huygens, in the library of the university of Leiden, there is a drawing of Saturn, made 1675, Dec. 8 (and which has been copied, and published by Kaiser in 1855), wherein the division in the ring, and the difference of brightness of the two parts, are clearly indicated. Above and on the side of the drawing, Huygens wrote, among other things, ". . . Saturnus cum comite observatus tubo 36 pedum Campani;

aderat de Cassinius. . . . [A description of the ball and the ring as seen by the observer here follows, and succeeding the words] quod a Josepho Campano jam olim observatum, ut figura ab ipso edita comprobat. . . ." When Huygens made this observation, Cassini was with him; but, from the notice in the *Philosophical transactions*, it is probable that Cassini saw the division of the ring in August or September, 1675; so that there is no sufficient ground to think that it was Huygens who showed the division to Cassini. But with regard to the allusion of Huygens to the observation of the two parts of the ring, made by Campani, and the figure of the same which he had published, Dr. Bakhuyzen searched in vain in different books for the figure until he found, between a number of letters addressed to Huygens from Leopold, Prince of Etruria (the same to whom Huygens dedicated his 'Systema Saturnium'), a sheet of paper with two printed drawings of Saturn and Jupiter. The details in the belts of the latter planet show that Campani's telescope was a very good one. The shadow of the ring is to be seen on the disk of Saturn; and the outer part of the ring, for somewhat less than half the total breadth, is dotted, whilst the inner part is bright. There is no line between the two parts, but they are distinctly separated from one another by the difference in brightness. One can also see traces of the inner dark ring. It is highly probable that the above words of Huygens refer to this figure of Saturn; and Dr. Bakhuyzen therefore concludes that Joseph Campani was the first astronomer who, by means of a very good telescope made by himself, saw distinctly the darker and the brighter part of the ring in 1664. It is, however, possible that Cassini was the first who saw the line of separation. The drawings of Saturn and Jupiter made by Campani are printed in 'Stanislai Lubiensecii de Lubienietz Theatrum Cometicum,' Pars prior, page 574. Lubienietz received the drawings from Athanasius Kircher in Rome.

— The proprietors of the *Melbourne age* have sent an exploring expedition to New Guinea.

— In the *Proceedings of the American philosophical society* (xx. no. 113) Professor Pliny Earle Chase has a long paper, thirty-three pages, on 'photodynamics,' in which, starting with 'combined cometary harmonics,' he comes out at 'lines of force and of motion;' and Professor George F. Barker gives an account of his very simple form of constant battery.

— The aeronautical exhibition was held in Paris, at the Palais du Trocadéro, from June 5 to 24, — one week longer than was the intention. There were a number of plans for flying-machines shown, but a strange lack of successful results.

RECENT BOOKS AND PAMPHLETS.

**** Continuations and brief papers extracted from serial literature without repagination are not included in this list. Exceptions are made for annual reports of American institutions, newly established periodicals, and memoirs of considerable extent.*

Adams, R. C. Evolution; a summary of evidence: a lecture delivered in Montreal, March, 1883. New York, *Putnam*, 1883. 44 p. 12°.

Amsterdam. — Wiskundig genootschap. Catalogus der bibliotheek. Amsterdam, *Sikken*, 1883. 8+112 p. 8°.

Béguyer de Chancourtois. Questions de géologie synthétique; études, documents et modèles exposés à l'exposition de 1883 à Madrid. Paris, *impr. nat.*, 1883. 27 p. 8°.

Bentley, R. The student's guide to structural, morphological, and physiological botany. London, *Churchill*, 1883. 490 p. 12°.

Bernard, G. Champignons observés à La Rochelle et dans les environs. Paris, *Baillière*, 1883. 300 p., 56 pl., atlas. 8°.

Boulnois, H. P. The municipal and sanitary engineer's handbook. London, *Spon*, 1883. 398 p. 8°.

Boussinesq, J. Cours d'analyse infinitésimale de l'Institute industriel du Nord. Lille, *Danel*, 1883. 28+254 p. 4°.

Carr, H. Our domestic poisons; or the poisonous effects of certain dyes and colors (especially those containing arsenic) used in domestic fabrics. London, *Ridgway*, 1883. 47 p. 8°.

Carton. Solutions raisonnées des exercises de géométrie contenus dans les deux cours de M. l'abbé Carton, professeur de mathématiques à l'institution Notre-Dame à Valenciennes. Paris, *Poussielgue*, 1883. 312 p. 12°.

Cassé, E. Aérostation pratique; épure et construction des aérostats et montgolfières, avec quatre planches explicatives. Paris, *Hennuyer*, 1883. 41 p. 8°.

Crié, L. Cours de botanique: organographie et familles naturelles pour la classe de quatrième, les écoles normales et les écoles d'agriculture. Paris, *Doin*, 1883. 12+481 p., 865 fig. 18°.

Daguillon. Entre vignerons à la veillée, causeries sur la culture de la vigne, la vinification et la conservation du vin. Clermont-Ferrand, *impr. Mont-Louis*, 1883. 463 p. 18°.

Davy, G. Tout par l'électricité. Tours, *Mame*, 1883. 475 p. 8°.

Dubois, A. Histoire naturelle vulgarisée, ornithologie populaire; grand et petite rapaces, oiseaux chasseurs. Limoges, *Barbou*, 1883. 124 p. 12°.

——— *The same.* Oiseaux fantastiques et oiseaux chasseurs. Limoges, *Barbou*, 1883. 125 p. 12°.

Duclau, S. La science populaire: les ballons et les premiers voyagers aériens. Limoges, *Ardant*, 1883. 143 p. 12°.

Fontannes, F. Note sur la découverte d'un Unio plissé dans le miocène du Portugal. Paris, *Savy*, 1883. 24 p., pl. 8°.

Graeff, A. Traité d'hydraulique, précédé d'une introduction sur les principes généraux de la mécanique. 3 vol. tom. i.: partie théorique, 8+333 p.; tom. ii.: partie pratique, 541 p.; tom. iii.: tables numériques, notes, errata, planches, 52 p. Paris, *impr. nat.*, 1883. illustr. 4°.

Herrick, C. L. Types of animal life, selected for laboratory use in inland districts. pt. i.: Arthropoda. Minneapolis, *Kimball pr.*, 1883. 33 p., [7] pl. 8°.

Holmes, A. Bromley. Practical electric lighting. New York, *Spon*, 1883. 154 p., illustr. 8°.

Johnston's new map of South Africa, with index. London, *Johnston*, 1883.

Lalande, J. de. Tables de logarithmes pour les nombres et pour les sinus. Revues par le baron Reynaud. Édition stéréotype, augmentée de formules pour la résolution des triangles, par M. Bailleul, typographe, et d'une nouvelle introduction. Paris, *Gauthier-Villars*, 1883. 42+236 p. 16°.

Lambert, J. The germ theory of disease concisely and simply explained. London, *Baillière*, 1883. illustr.

Lyras de Moléon. La mer, description de ses merveilles, ses curiosités les plus remarquables. Limoges, *Ardant*, 1883. 144 p. 12°.

Martin and **Watson.** Handbook to the fernery and aquarium. London, *Unwin*, 1883. illustr.

Mascart, E., and **Joubert**, J. A treatise on electricity and magnetism. Translated by E. Atkinson. vol. i. London, *De la Rue*, 1883. 662 p. 8°.

Oliver, J. A. W. Sunspottery; or, What do we owe to the sun? A popular examination on the cycle theory of the weather, famines, pestilences, commercial panics, etc. London, *Simpkin*, 1883. 54 p. 8°.

Pierret, P. Le livre des morts des anciens Égyptiens. Traduction complète d'après le papyrus de Turin et les manuscrits du Louvre, accompagnée de notes et suivie d'un index alphabétique. Paris, *Leroux*, 1882. 9+665 p. 18°.

Simmonds, P. L. A dictionary of useful animals and their products: a manual of ready reference for all those which are commercially important, and others which man has utilized; including also a glossary of trade and technical terms connected therewith. London, *Spon*, 1883. 136 p. 12°.

Woolcock, J. Studies in anthropology; or, lectures on man. London, *Partridge*, 1883.

SCIENCE.

FRIDAY, AUGUST 10, 1883.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Next week will see the annual meeting of the American association for the advancement of science. Although the pendulum-like swing of its migration takes it this year to the westernmost point of its meetings, — to a flourishing city that was founded since the association began its good work, — there is a promise of a larger and more successful meeting than has been its lot to have for several years. Though its roots go down slowly, there is good reason to believe that this society is at last taking firm hold in our hard and stubborn American society, which long seemed to deny it a fair chance of growth. It was, in fact, a much more serious task than it at first seemed, to create in America an association on the basis of that which grew so rapidly and so well in the British mother-country. The success of the British association was due in the main to the fact that the distances the members had to travel were small, so that a large part of the working members could be relied on to attend from year to year in a regular way; thus giving a continuity to its intellectual life that has been denied to our association. Then in Britain, and the sister kingdom of Ireland, there are a score or more places where there exists a strong local life, a pride in the reputation of locality, and a mass of inherited wealth liberalized by long tradition that could easily be brought to the support of such meetings. Still more effective was the support which a centralized government could give, and the money that came easily at the call of the scientific leaders who made themselves responsible for the work the association undertook. All these advantages were denied to the American association in its earlier years. In the most of its meeting-places there was little to uphold its work; it toiled as a missionary enterprise — patiently, but with scanty reward. Its recent gain in public esteem has been in part the result of its own good and devoted work, but in larger measure it is the result of the exceedingly rapid change in the condition of American city life. The frontier spirit in our American towns, the greed for immediate ends, is passing away. Few towns of twenty thousand people but have their leisured class, or are without some well-shaped ambition for a good name among men of learning. Although the association was, in its earlier years, somewhat before its time, our life is fast growing up to be a support for such work as it seeks to do. Every friend of learning will welcome the assurance of strong life that these changes give to the association, and will look forward to its future with confidence in its work.

Experience that we may gain from the results of the association and of its kindred societies in the mother-country and on the continent shows us clearly what this work should be. First of all is the good-fellowship, the solidarity that is bred by bringing together in one assembly people who have no other chance to get the light from each others' eyes or the spirit from their fellow-workers' tongues. However we may value the material gain of fact, there can be no doubt that this is the precious thing which the association can give to American science. Our workers are necessarily scattered by the geographical immensities of their land; the teaching that the nature about their homes gives them is, from the conformity of conditions in almost all neighborhoods, limited and incomplete. More than any other men of science, they need a season of contact with those trained amidst other conditions. Some things grow well in a corner, but natural science is not of them. Whoever has brought to a meeting of the American association memories of similar gatherings in

Europe must have felt that this social element in our society left much to be desired. The writer recalls the time when he attended the Swiss association at Rheinfelden in one year, and the American the next, in a rather gloomy manufacturing town. At the Swiss meeting all the members dined together in a garden on the banks of the Rhine, after the morning session had been gone through with all due solemnity. There was, be it confessed, much wine, but so much wit and wisdom, withal, that the very prophets of teetotalism would have been moved to sympathy. In the social fire that only a table can provoke, in ordinary mortals at least, these diverse folk, separated by race and tongue, were fused into unity and brotherhood.

Making all due allowance for our inherited need of taking diversions a little sadly, it does seem that we might heighten the social element in our meetings. Even the most august British societies descend to tea after the meetings, and find their profit in it from the closer and more familiar life that it gives. Although we use it little, our American folk have an unequalled capacity for after-dinner talking; half our folk have the *toast-master* in them: so we need not fear that such gatherings would be dull.

Coming to the apparently more scientific aspects of its labors, maintaining the while that the science of good-fellowship is the prince of all learning, let us consider some other parts of the association's work. The experience of the British association seems to show that they succeed in avoiding the extreme haphazard nature of the discussions which mark our own association. This is in part due to the continuity of attendance of its leading members, but it seems as if a part of its gain in this direction had been due to the fashion of having special committees charged with the study of large questions of public interest. Coming to the association with their minds full of the results of especially designated inquiries, the committee-men have been able to give an element of direction to its discussions that have often made them admirably deliberative, and exceedingly profitable to all who heard them. If our association would take care to provide committees with important inquiries, and could furnish them with the money necessary for the securing of information when such aid was required, we might have each year a solid body of matter which would insure a profit to all who might attend. Giving these reports and their discussion the precedence in the meetings, the vagarists, the lost tribes of circle-squarers, law-finders, and others who wander in the wilderness, would not be able to render the sessions unprofitable to students, as they not unfrequently do, even in these latter days of the association.

There is yet another chance of bettering the association-work. One of its highest aims is to foster the spirit of philosophical inquiry among the people with whom its lot is cast from year to year. Something, but not much, may be accomplished by the mere presence of notable men, and their wise words. Yet the odor of the sanctuary is but fleeting: it is not in the least a monumental thing. The ordinary citizens or the school-children mark the fact that for a week some hall puts on a beehive look; the papers have reports, mostly incomprehensible; and then the matter is forgotten. There seem to be several ways of increasing the local effects of these meetings. First, there should be a careful preliminary study of the scientific problems that the neighborhood affords, a sufficient presentation of those that are understood, and a suggestion of inquiries thereafter to be made. This should be printed, and would serve for a local guide for the use of the association, and as an incentive to local workers. Then, if it seems well, the association should offer some small prize to those students on the ground who would carry farther the inquiries that this report has shown to be desirable. If the conditions permit, the association would do well to see that some local society, such as the field-clubs that were recently advocated in these columns, should be created, to remain as a successor to its objects and a fosterer of its work. In the inspiration that these meetings generally arouse, such a society might even secure a small fund for its maintenance.

Last, and if such a work be possible, best of all, the association might, through a proper committee, do much to promote science-teaching in the schools of the cities where it each year bides. Every meeting of the association has among its attendants those who have the much-needed skill in the matter of teaching science. There is hardly a public school in the land where there is not a crying need of such help as could best be given at such times. There should be a committee, or even perhaps a section of the association, devoted to the promotion of sound teaching in natural science; for the gravest danger before this branch of learning is to be found in the radical imperfection of the methods of science-teaching in use in our schools. These suggestions may seem to lay heavy burdens of advice on the association, but none of them seem beyond the promise of its strength.

RECENT EXPLORATIONS IN THE REGION OF THE GULF-STREAM OFF THE EASTERN COAST OF THE UNITED STATES BY THE U. S FISH-COMMISSION.[1]

4. Nature and origin of the deposits.

Along part of the Gulf-Stream slope examined by us, the bottom, in 65 to 150 fathoms, 80 to 110 miles from the shore, is composed mainly of very fine siliceous sand, mixed with a little clay, and containing always a considerable percentage of the shells of Foraminifera and other calcareous organisms, and frequently spherical, rod-like, and stellate sand-covered rhizopods, sometimes in large quantities. Among the Foraminifera, Globigerina is abundant; but many other forms occur, some of them of large size and elegant in form. Grains of green sand (glauconite) were frequently met with, but were not abundant. Large quantities of the tubes of annelids frequently occur. Some of these are made of cemented mud, fine sand, or of gravel; others, of parchment-like secretions. On the inshore plateau, and also in the deeper localities on the slope, there is usually more or less genuine mud or clay; but this is generally mixed with considerable fine sand, even in 300 to 600 fathoms. The sand, however, is often so fine as to resemble mud, and is frequently so reported when the preliminary soundings are made. In several localities the bottom was so 'hard,' in 65 to 125 fathoms, that the bulk of the material brought up consisted of sponges, worm-tubes, shells, etc., with some gravel, but with neither mud nor fine sand. Such bottoms were very rich in animal life. In many instances, even in our deeper dredgings (about 700 fathoms), and throughout the belt examined, we have taken numerous pebbles, and small, rounded bowlders of all sizes, up to several pounds in weight, consisting of granite, sienite, mica schist, etc. These are abundant in some localities, and covered with Actiniae, etc. Probably, while frozen into the shore-ice in winter and spring, they have been recently floated out from our shores and rivers, and dropped in this region, where the ice melts rapidly under the influence of the warmer Gulf-Stream water. Probably much of the sand, especially the coarser portions, may have been transported by the same agency.

Another way, generally overlooked, in which fine beach-sand can be carried long distances out to sea, is in consequence of its floating on the surface of the water after it has been exposed to the air, and dried on the beaches. The rising tide carries off a considerable amount of dry sand, floating in this way. In our fine towing-nets we often take more or less fine siliceous sand which is evidently floating on the surface, even at considerable distances from the shore. The vast sand-beaches, extending from Long Island to Florida, afford an inexhaustible supply of this fine sand.

The prevalence of fine sand along the Gulf-Stream slope in this region, and the remarkable scarcity of fine mud or clay deposits, indicate that there is here, at the bottom, a current usually sufficient to prevent, for the most part, the deposition of fine argillaceous sediments over the upper portion of the slope, in 65 to 150 fathoms. Such materials are probably carried along, for the greater part, till they eventually sink to greater depths, nearer the base of the slope, or beyond in the ocean-basin itself, where the currents are less active. Doubtless, there are also belts along which the northern current meets and opposes the Gulf Stream, causing less motion, and favoring the deposition of fine sediments. It is probable that motion of the water along the upper part of the slope may also be caused by tidal currents, which would modify the north-eastern flow of the Gulf Stream, both in direction and velocity. Currents produced by protracted storms might have the same effect. In depths

[1] Continued from No. 19.

greater than 200 fathoms on the outer slope, and in 25 to 60 fathoms on the inshore plateau, there is doubtless a slow, cold current to the south-west. It is not probable that these bottom-currents are strong enough to move even the fine sand after it has once actually reached the bottom; nor is it strong enough to prevent the general deposition of oceanic foraminifera, pteropods, etc.

The existence of actual currents in this region, sufficiently powerful to directly effect an erosion of the bottom, is hardly supposable. Such a result may be effected, however, in consequence of the peculiar habits of certain fishes and crustacea that abound on these bottoms. Many fishes, like the 'hake' (Phycis), of which three species are common here, have the habit of rooting in the mud for their food, which consists largely of Annelida and other mud-burrowing creatures. Other fishes, those with sharp tails especially, burrow actively into the mud or sand, tail first; and in all probability Macrurus, abundant on these slopes, has this habit. Several burrowing species of true eels and eel-like fishes are very abundant on these bottoms. Many of the crabs and other crustacea are active burrowers. Such creatures, by continually stirring up the bottom sediments, give the currents a chance to carry away the finer and lighter materials, leaving the coarser behind.

In many localities there are great quantities of dead shells, both broken and entire. A small proportion of the unbroken bivalves have been drilled by carnivorous gastropods, but there are large numbers that show no such injury. These have, for the most part, undoubtedly served as food for the star-fishes and large Actiniae, abundant on these grounds, and from which I have often taken many kinds of entire shells, including delicate pteropods. Many fishes, like the cod, haddock, hake, flounders, etc., have the habit of swallowing shells entire, and, after digesting the contents, they disgorge the uninjured shells. Such fishes abound here. Species of Octopus are also known to feed upon bivalves without breaking them, and O. Bairdii is common in these depths. The broken shells have probably been destroyed, in large part, by the large crabs and other crustaceans having claws strong enough to crack the shells. The large species of Cancer and Geryon, and the larger Paguri, abundant in this region, have strength sufficient to break most of the bivalve shells. Many fishes that feed on mollusca also crush the shells before swallowing them. Both fishes and crabs have, doubtless, thus helped to accumulate the broken shells that are often scattered abundantly over the bottom, both in deep and shallow water. Such accumulations of shells would soon become far more extensive than they are, if they were not attacked by boring sponges and annelids. Certain common sponges, belonging to the genus Cliona, very rapidly perforate the hardest shells in every direction, making irregular galleries, and finally utterly destroying them. On the outer grounds we dredge up rarely fragments of wood; but these are generally perforated by the borings of bivalves (usually Xylophaga dorsalis) and other creatures, and by them would evidently soon be destroyed.

We very rarely meet with the bones of vertebrates at a distance from the coast. Although these waters swarm with vast schools of fishes, while sharks, and a large sea-porpoise, or dolphin (Delphinus, sp.), often occur in large numbers, we very rarely dredge up any of their bones. In a few instances we have dredged a single example of a shark's tooth, and occasionally the hard otoliths of fishes. It is certain that not merely the flesh, but most of the bones also, of nearly all the vertebrates that die in this region, are very speedily devoured by the various animals that swarm on the bottom. Echini are very fond of fish-bones, which they rapidly consume. Fishes caught on the hooks in this region, and left down an hour or two, were nearly stripped of their flesh by small amphipod crustacea.

Relics of man and his works are of extremely rare occurrence at a distance from the coast, or even at a short distance outside of harbors, with the exception of the clinkers and fragments of coal thrown overboard from steamers with the ashes. As our dredgings are in the track of European steamers, such materials are not rare. A few years ago, even these would not have occurred. A rock forming on this sea-bottom would, therefore, not contain much evidence of the existence of man, nor even of the commonest fishes and cetaceans inhabiting the waters.

5. Fossiliferous magnesian limestone nodules.

At several localities in 234 to 640 fathoms, we dredged fragments and nodular masses or concretions of a peculiar calcareous rock, evidently of deep-sea origin, and doubtless formed at or near the places where it was obtained. These specimens varied in size from a few inches in diameter up to one irregular nodular or concretionary mass taken in 640 fathoms, which was 29 inches long, 14 broad, and 6 thick, with all parts well rounded. These masses differ much in appearance, color, texture, and fineness of grain; but they are all composed of distinct particles of siliceous sand, often very fine, cemented by more or less abundant lime and magnesia carbonates. Sometimes small quartz pebbles occur in them. The fine-grained varieties of the rock are often exceedingly compact, hard, and tough, usually grayish or greenish in color. They are often bored by annelids, sponges, etc., and are usually weathered brown, due to the presence of iron (probably in part as carbonate, sometimes as pyrite). The sand consists mainly of rounded grains of quartz, with some felspar, mica, garnet, and magnetite. It is like the loose sand dredged from the bottom in the same region. The calcareous cementing material seems to have been derived mainly from the shells of Foraminifera, abundantly disseminated through the sand just as we find the recent Foraminifera in the same region. In some cases, distinct casts of Foraminifera are visible in the rock. In some pieces of the rock, distinct fossil shells were found, apparently of recent species (Astarte, etc.). The larger masses appear to have been originally concretions in a softer deposit, which has been more or less worn away, leaving the hard nodules so exposed that the trawl could pick them up. The age of these rocks may be as great as the pleistocene, or even the pliocene, so far as the evidence goes. No rocks of this kind are found on the dry land of this coast. It is probable, however, that they belong to a part of the same formation as the masses of fossiliferous sandy limestone and calcareous sandstone, often brought up by the Gloucester fishermen from deep water on all the fishing-banks, from George's to the Grand Bank.

The chemical composition of these limestone nodules is of much interest geologically. Analyses made by Prof. O. D. Allen prove that they contain a considerable amount of magnesia. They are, therefore, to be regarded as magnesian limestones, or dolomites, of recent submarine origin. They also contain a notable quantity of calcium phosphate. The presence of the latter is not surprising when we consider the immense number of carnivorous fishes, cephalopods, etc., which inhabit these waters, and feed largely upon the smaller fishes, whose comminuted bones must, in part at least, be discharged in their excrements. In fact, it is probable that the greater part of all the mud and sand that cover these bottoms has passed more than once through the intestinal canals of living animals. The Echini, holothurians, and many of the star-fishes and worms, continually swallow large quantities of mud and sand for the sake of the minute organisms contained in it, and from which they derive their sustenance.

The following partial analysis by Prof. O. D. Allen gives the percentage of the most important constituents. The sample analyzed was a hard, compact, and very fine-grained magnesian limestone. Its color was yellowish green, with a darker green surface, weathered rusty brown in some places. It contained some minute specks of iron pyrite. Its specific gravity was 2.73.

Composition of a deep-water limestone.

	Per cent.
Lime	24.95
Magnesia	14.41
Iron (estimated as protoxide)	2.00
Phosphoric acid (not weighed).	
Insoluble residue (sand)	16.97

WATER-BOTTLES AND THERMOMETERS FOR DEEP-SEA RESEARCH AT THE INTERNATIONAL FISHERIES EXHIBITION.

It would naturally be expected that at an exhibition of this kind in England, where so much has been done in the past for deep-sea investigations, there would be found a good collection of the apparatus used in deep-sea work. Great Britain has, in fact, shown almost nothing of the kind; indeed, one may say, nothing whatever that especially relates to deep-sea investigation. After spending the not inconsiderable sum of money required to fit out the Challenger, the British government seems to have lost all interest in deep-sea exploration; and other nations are carrying on the work with greatly improved apparatus, while Great Britain rests content with the laurels already won.

The United States exhibit is the most complete of all, as regards apparatus of this kind. Denmark and Sweden have some apparatus for collecting specimens of water and observations of temperature, which, with the later forms used by the U.S. fish-commission and by the coast-survey, will form the main subject of this article.

The Swedish apparatus was devised by Prof. F. L. Ekman, principally for the use of the Swedish expedition of 1877, which carried out very thorough and systematic hydrographic investigations in the waters extending from the North Sea, through the Baltic, to the extreme end of the Gulf of Bothnia. Although the apparatus worked with entire satisfaction, it would scarcely be used at the present time, for it is unnecessarily heavy and large.

Two forms of apparatus for collecting samples of water from different depths are shown, both constructed on the same principle. The larger, having an ingenious means of closing, is chosen for description here. It consists of a brass cylinder open at both ends, about ten inches in length by four and a half in diameter, sliding freely through a space somewhat greater than its length, between three vertical brass rods or guides, which also constitute the frame of the apparatus. When the cylinder slides down, it encloses a vertical rod having a horizontal plate at the top, which forms a tight cover for the cylinder, similar to the end of a piston. The bottom of the cylinder falls into an annular groove in which a sheet-rubber ring is fitted, thus making a tight joint below. A rubber ring is also employed to make the upper joint tight. In the smaller instrument the lower groove is filled with a mixture of suet and wax; and the cylinder has an annular plate on top, the border of which extends inwards sufficiently to be bent downward so as to fit into a similar groove on the upper surface of the horizontal disk forming the top of the closed chamber. When the apparatus is sent down, the cylinder is suspended at the top. When it reaches the desired depth, the cylinder is released by a mechanism to be described, and falls, enclosing a sample of the water. In the smaller apparatus the cylinder is sustained during descent by the resistance offered by the annular plate above referred to, which is considerably larger than the diameter of the cylinder. On drawing up the apparatus, the plate also acts to force the cylinder well down into the grooves. In the larger instrument the cylinder is held up by a catch, actuated by a system of levers, which are connected with a turbine wheel enclosed in a brass case at the top. During descent the water passes through the case, entering and leaving it freely through strainers of brass gauze, and causes the turbine to revolve. The latter turns freely until the desired depth is reached. When ascending, the wheel makes a certain number of revolutions in the opposite direction, and soon acts upon the system of levers through a ratchet and ratchet-wheel, thus releasing the cylinder. This instrument has been successfully used in depths of three hundred metres. It is sufficiently good to enable the quantity of air contained in the water at different depths to be determined.

Arfwidson's water-bottle, exhibited by Denmark, is a simple cylinder of brass, shaped somewhat like a bell, closed by bottom and top plates with bevelled edges connected by a central stem. The bell falls. and the whole apparatus is drawn up by the central rod. The joints are made tight by grinding the plates and cylinder together. It is very simple, very light, and seems to be a good instrument. No information concerning its use is available at the present moment.

Another of Professor Ekman's instruments is used to collect samples of water, and also to enable the temperature to be correctly determined. Although quite different in construction from the others, it is the same in principle, except that it is made to protect the sample from any change of temperature while being drawn up, so that a thermometer may be introduced on deck to get the temperature of the stratum of water from which it was taken. The instrument has been found to give accurate results at depths of two hundred metres. It is not stated whether it has been used at greater depths.

In this instrument the cylinder is fixed between two galvanized iron rods, which, with four horizontal circular bands of the same material outside, constitute the frame, resembling a sort of cage. The top and bottom of the cylinder are formed by what may be described as two piston-heads connected together by a hollow rod, which slides up and down on another rod running vertically through the middle of the apparatus. The piston-heads are made of thick gutta-percha secured between brass plates. The connecting-rod is also covered with gutta-percha, and the cylinder itself is lined with it. Rubber is used to make the joints perfectly tight. The sample of water is thus protected by gutta-percha in every direction about two and a half centimetres in thickness. The upper piston-head carries a brass plate, which offers sufficient resistance to the water, while descending, to sustain it at the top of the apparatus. On hauling in, the water forces the piston down into the cylinder, enclosing the sample. The apparatus gives remarkably good results, if we may judge from some of the figures given in the case of a series of temperatures taken in the Baltic, where the alternations of cold and warm strata were quite remarkable. The temperatures were recorded to tenths of a degree of Celsius's scale, as, indeed, it was necessary that they should be, in order to make the results of unquestionable value; for the total variation in temperature between depths of 50 metres (when the temperature was 1°.8) and the bottom, 210 metres, was only 2°.1 C., yet there was a rise to 3°.9 at 100 metres, and a fall to 3°.1 at 210 metres.

No one would undertake to obtain such results with any deep-sea thermometer in use at that time. The Miller-Cassella instrument would utterly fail to record the temperatures at the bottom; and, even if it did record them, its readings would not be regarded as within half a degree F. of the exact temperature. The Siemens electric apparatus, which has been used on the Blake with great success, cannot be depended upon for greater accuracy than a quarter of one degree.

Fig. 1.

Capt. G. Rung of the Danish meteorological institute exhibits some thermometers enclosed within thick layers of cork, only the scales being exposed to view. In this way it is possible to obtain deep-water temperatures; for the instruments can be hauled upon deck, and readings made, before any heat can pass through the cork. This method, however, seems rather primitive; and, even if practicable, it is quite too slow to receive much commendation.

There can be no doubt that the best deep-sea thermometer is the latest Negretti and Zambra form, represented in fig. 1. It is so well known that a full description is not necessary; but as a reminder it may be said, that, when the instrument is upright, the mercury extends up into the tube to a height corresponding to the temperature. If then inverted, the mercury breaks at a particular point in the bend A, and runs down to the other end, where the temperature is read off. The small quantity of mercury in the bore does not appreciably change its length for slight variations of temperature. For a long time this has been the favorite instrument for taking deep-sea temperatures singly, but until lately no means had been devised for taking serial temperatures with it at a single cast. At the fisheries exhibition are shown three new methods of inverting the instrument at a given depth. The first we shall mention is exhibited by Capt. G. Rung of Denmark. It is scarcely worth while to describe this apparatus in detail; for, although it is undoubtedly an excellent device, the two other methods to be described are much better, because they are lighter and smaller. Capt. Rung inverts the thermometer by sending down a messenger along the line. By causing the inversion of each instrument to free a messenger to invert the next instrument below it, he obtains serial temperatures in the same manner as is done with the new device of Mr. W. L. Bailie, to be soon described.

Capt. Rung also exhibits a water-bottle and thermometer combined. A brass cylinder, perforated at the bottom with three small orifices, has a piston working air-tight within it. Within the piston-rod, which is perforated here and there, is a Negretti and Zambra thermometer, the bulb being at the outer extremity of the rod.

To use the apparatus, the piston is shoved in, and the end of the sounding-rope tied to the projecting end of the piston-rod. The apparatus is then inverted; and the lower end of the cylinder, being now uppermost, is secured to a catch a short distance up on the line. In this position it is lowered to the required depth, when a messenger is sent down which releases the cylinder. It falls, turns over, and the weight is then transferred to the piston-rod. The thermometer, being now bulb up, registers the temperature; while the weight of the cylinder causes it to pull the piston-rod out to the fullest extent, and, as the piston rises, it draws the water into the cylinder through the small holes in the bottom.

In figs. 2 and 3 we have illustrations of the ingenious apparatus devised by Commander Magnaghi of the Royal Italian navy, and exhibited by Messrs. Negretti and Zambra. It will be seen that the propeller-wheel C screws up or down as it revolves. During descent the propeller does not move, as the pin F is against the stop G. On reversing the motion, the propeller screws upward until the screw E releases the case, which then turns over, as in fig. 3, and is held in position by the spring K.

A still later form of this instrument has just been made, in which the thermometer-case is suspended on trunions at the lower end, instead of near the middle.

Another method for accomplishing the same result has been devised by Mr. W. L. Bailie, U S.N. In his arrangement the case of the thermometer is attached to the sounding-wire by a cam-catch at the bottom, and by two lateral spring jaws at the top, which encircle the wire.

A brass messenger is sent down the wire when the desired depth is reached, which opens the jaws, thus releasing the top of the case. The latter then falls over, turning on a swivel at the bottom. A hook at the bottom carries a second messenger, which is released as the case turns over, and falls down to invert the next instrument; and so on through the series. Instead of sending down a messenger on the wire, a propeller-wheel has also been arranged to open the jaws, so that either method may be employed.

The question arises, whether, with these excellent methods of using the instrument, the Negretti and Zambra thermometer cannot be made to record accurately to tenths of a degree. It would seem, that, by giving it a short range and a comparatively long tube,

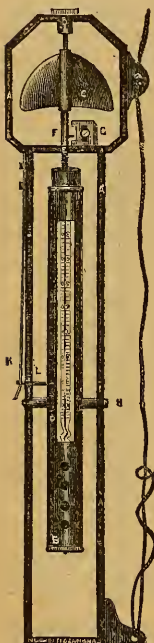


Fig. 2.

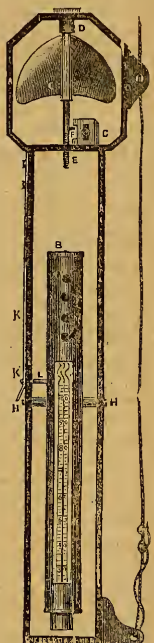


Fig. 3.

this might be done. If not, the most delicate observations for sub-surface temperatures will probably have to be made with some form of apparatus, which, like that used by Professor Ekman, brings the water to the surface in a case covered with a material through which heat cannot readily pass, or else by sending down a thermometer enclosed, like Capt. Rung's, in a thick case of non-conducting material.

R. Hitchcock.

London, June 1, 1883.

REAL ROOTS OF CUBICS.

THEOREM I.

[In the equation $x^3 + Ax^2 + B = 0$, when the roots are real, A and B have opposite signs; and simultaneously changing the signs of A and B changes signs of roots of equation.]

Assume $x = a$, $x = b$, $x = -\frac{ab}{a+b}$.

$$x^3 - \frac{1}{a+b}(a^2+ab+b^2)x^2 + \frac{1}{a+b}(a^2b^2) = 0; \quad (1)$$

and, changing signs of roots,

$$x^3 + \frac{1}{a+b}(a^2+ab+b^2)x^2 - \frac{1}{a+b}(a^2b^2) = 0. \quad (2)$$

Since the factors (a^2+ab+b^2) and (a^2b^2) are positive when the roots are real, whatever the sign of $\frac{1}{a+b}$, A and B will have opposite signs, and, from (1) and (2), simultaneously changing signs of A and B changes signs of roots of equation.

THEOREM II.

$\left[\frac{A^3}{27}\right.$ is greater than $\frac{B}{4}$ in quantity.$\left.\right]$

$$\text{Assume} \quad \left(\frac{a^2+ab+b^2}{3(a+b)}\right)^3 > \frac{a^2b^2}{4(a+b)} \quad (3)$$

$$\text{or} \quad \left(\frac{a^2+ab+b^2}{3}\right)^3 > a^2b^2\left(\frac{a+b}{2}\right)^2;$$

$$\text{but} \quad \left(\frac{a+b}{2}\right)^2 \geq ab \quad \text{(Algebra):}$$

hence inequality (3) is true.

From (1), omitting the term $\frac{A}{3}$,

$$\frac{x}{\left(-\frac{B}{4}+\frac{A^3}{27}\right)^{\frac{1}{3}}} = \left(1+\frac{\sqrt{\frac{B}{4}}}{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}\sqrt{-1}\right)^{\frac{2}{3}} + \left(1-\frac{\sqrt{\frac{B}{4}}}{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}\sqrt{-1}\right)^{\frac{2}{3}}; \quad (4)$$

and, from (2),

$$\frac{x}{\left(\frac{B}{4}\right)^{\frac{1}{3}}} = \left(1+\frac{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}{\sqrt{\frac{B}{4}}}\sqrt{-1}\right)^{\frac{2}{3}} + \left(1-\frac{\sqrt{-\frac{B}{4}+\frac{A^3}{27}}}{\sqrt{\frac{B}{4}}}\sqrt{-1}\right)^{\frac{2}{3}}. \quad (5)$$

In (4) the coefficient of $\sqrt{-1}$ may have any magnitude, and in (5) the coefficient of $\sqrt{-1}$ is the reciprocal of that magnitude. And since from any cubic (Theorem I.) (4) or (5) may be obtained, it follows, that, when the real part is unity, the coefficient of $\sqrt{-1}$ may be made less than unity, and real (Theorem II.).

Put n = coefficient of $\sqrt{-1}$, we have, by expansion,

$$(1+n)^{\frac{1}{3}} + (1-n)^{\frac{1}{3}} = 2-4\left(\frac{1}{3.6}\right)n^2 - 4\left(\frac{4.7}{3.6.9.12}\right)n^4 - 4\left(\frac{4.7.10.13}{3.6.9.12.15.18}\right)n^6, \text{ etc.}$$

The series, already converging, is made doubly converging by the high powers of n, since n has been made a fraction. Putting n, for example, no smaller than $\frac{1}{10}$, the correction for the sum of the series at the eighth term would be less than $\frac{1}{1,400,000,000,000,000,000}$. And, as the precision of the value of x is determined proportionally to the accuracy with which the series is summed, it follows that a good approximation to x may be obtained by using a very few first terms of the series.

A. M. SAWIN.

THE HABITS OF MURAENOPSIS TRIDACTYLUS IN CAPTIVITY; WITH OBSERVATIONS ON ITS ANATOMY.

THE Louisianian district of the Austroriparian region is a particularly rich field for the herpetologist. Thirty-six species of reptiles are known to be confined to its limits alone, not to mention a long list of others that range generally over the southern states; and to these we must add those species which are mentioned by the old French authors, but have not yet been taken by American naturalists, a knowledge of which fact always enhances the interest of a country in the eyes of the explorer, who pushes his way through its tangled jungles, or visits its unfrequented spots and its sultry forests, for the first time.

FIG. 1.—Life-size head of Muraenopsis tridactylus; adult. Drawn from the living specimen by the author.

After my arrival in New Orleans, the months that are included in the pseudo-winter of this sub-tropical land came and passed by, before my collection could boast of a single specimen representing the Amphiumida: indeed, it was not until April had almost made its appearance that a superannuated old negro presented himself one morning with a live but rather small specimen of the three-toed siren, the subject of this essay.

He called it a 'Congo eel,'—a name which is indifferently applied by every one here, intelligent as well as ignorant, to both this reptile and Amphiuma means. Long before this, reports had come to me from far and near of the dreaded 'Congo,' or 'lamprey' as it is often called. It was universally said that its bite was invariably fatal. To such an extent was this believed, that, I am told, a physician of the city, of undoubted reputation in his profession, and a capital chemist, but possessing nothing more than a general knowledge of natural science, was actually making experiments with the view of examining the venom of this innocent amphibian. When my aims became pretty thoroughly known throughout my section of the country, I applied a very different kind of analysis to this problem: a good round sum of money was offered to any one who would bring me the full record of a well authenticated case of death from the bite of the Congo snake, or eel. It is almost needless to add, that I never had to pay the reward. One person, more mercenary than well informed in such matters, did bring forward a case of an hysterical old colored woman who had been bitten several years ago by a Congo eel, and died *six months* after the infliction of the wound, in spasms!

The small one, which now came into my possession, was placed in water, in a large comfortable vessel, for observations upon his habits, before he was finally consigned to his tank of alcohol. In handling him, he rarely offered to bite, unless the examination was prolonged or roughly conducted; then he would curl up, slowly open his mouth, and make an awkward longe at the fingers or hand that held him. Sometimes he would only open his mouth, and hiss in a subdued manner. On one occasion, however, this reptile succeeded in getting out of his tub during the night. When I found him, in the morning, in a distant part of the room, he snapped at me quite savagely several times before he was retaken. It was amusing to see the way in which he succeeded in leaping out of his place of confinement, — a large tin bath-tub, with the water seven or eight inches below the brim. He swam round and round with increasing rapidity till the necessary impetus was acquired, when he would prettily make a sort of spring over the side of his tub on the floor, where he would squirm round like an eel until he was replaced. In such situations he uses his legs to the full extent to which they seem capable of being put; in the water, too, these members are constantly brought into use, — the fore-pair when he desires to move very slowly forward, in which case he may or may not, generally not, use the hind-pair in aiding the action. The fore-pair are also used alternately to push himself one way or another, when he wishes to change his course. A common use for the hind-pair, is to throw them forward, and brace them against the ground he may be passing over, in order to check his onward movement either partially or entirely. In swimming about he has all the appearance of the common eel; and during these times he draws both pairs of limbs close beside his body, when his action is graceful and interesting to behold.

When these sirens are at rest, they either stretch out in gentle curves, sluggishly along the bottom, or, what is not very uncommon for them to do, curl up tightly, in a spiral manner, the latter two thirds of their length, while the head and remaining third is protruded forward in a direct line. In this curious position they float near the surface, the head being lowermost. If two occupy the same vessel, they often curl about each other in a rather affectionate manner; but I have never witnessed them quarrel or fight. One time I threw a dead king-snake into the tub of my first small specimen, the snake being at least three times as long as the siren. Imagine my surprise to see him fly at the intruder, seize him just below the head, straighten out as stiff as he could, then rapidly whirl round, as a drill does, causing the dead snake to be spirally coiled about his body. A moment of quietude followed this strange manoeuvre, during which time one could see a crunching movement on the part of the jaws of the siren going on; but, finding his enemy showed no resistance, he slowly let go his hold, and, freeing himself from the dead snake's coils, swam about the tub without paying him any further attention. In a few moments, however, I repeated the experiment, when he made the same attack with just as much vigor as before; but all subsequent trials failed, and I could never induce him to take further heed of such a harmless enemy.

This siren will eat crayfish in confinement; but I could never induce one to take any thing else, although raw meat is the commom bait used by the negroes in catching them for me. Sometimes before a meal, or may be after, your captive will swim gracefully about his limited quarters, and occasionally rise to the surface, stick his nose out of the water, and give vent to a loud blowing sound, that may be heard anywhere in a large room, even if conversation be going on. As remarked above, my collectors usually took such specimens as were brought me, with the ordinary hook and line, baited with fresh meat; but very often they are captured in hand dip-nets, or even thrown out of a shallow drain or bayou with a stick. They are most numerous after heavy rains, when their usual places of resort are flooded over. When taken by others than those who are collecting for me, they are invariably despatched on the spot, and dreadfully and wantonly mutilated, so deep-seated is the detestation and dread of this harmless creature in the minds of all the people hereabout.

In a large, shallow tank of water, I have before me now two fine living specimens of this siren, which have been under my observation for nearly a fortnight. The larger of these two has a total length of eighty centimetres, with a mid-girth of fourteen centimetres. I have kept specimens alive that measured a hundred or more centimetres, but they have since been consigned to alcohol. The specimen now before me, just measured, is of a dark olivaceous brown above, and entirely so on all the parts beyond the hind-pair of limbs. A patch of this color is also found upon the throat. The color of the under parts is a dull, whitish leaden hue, being mottled with an intermediate shade as it joins the darker and more sombre color of the dorsal aspect of the body. This mottling grows denser as it approaches the hinder limbs, where finally it merges into the general tint of the upper surface, which is carried over the tail. A faint lateral crease is found along the mid-third of the body, with feeble corrugations crossing it vertically, that are quite evident as the creature writhes about, and the eel-like slime that naturally covers his entire body partially dries. The limbs are pretty well developed: each is three-fingered, or, better, each possesses three digits. The hinder limbs are larger than the fore ones, and stronger in every way. The body tapers to a tail beyond the genital fissure, but no well-marked constriction indicates to us its exact commencement, or attachment to the body. It is rounded beneath, and finished off along the median dorsal line with a thickened, feebly pronounced crest. Sections made through the body itself, between the fore and hind limbs, are elliptical, with the major axes in the horizontal plane. I have taken other measurements from this specimen, which I present in the form of a table.

Total length	80.0	cent.
Mid-girth	14.0	"
Length of fore-limb	1.7	"
" " hind-limb	2.5	"
" " head	6.5	"
Distance between the eyes	2.0	"
" " " nostrils	.6	"
" " mid-points bet'n eyes and nostrils,	2.2	"
Gill-cleft from eye	4.2	"
Fore-legs apart	3.1	"
Hind-legs "	2.2	"
Length of genital fissure	1.2	"
Commissure of jaw from gill-cleft	3.0	"
From a point midway between hind-limbs to tip of tail,	20.0	"

The nasal apertures are very small, and the eyes are black, round, a little more than a millimetre in diameter, and devoid of lids.

I may remark here, that, while engaged in taking these measurements, this specimen succeeded in seizing my thumb in his mouth, and immediately commenced his peculiar gyrations, turning himself in the long axis of his body; but I was too strong for him, and soon disengaged myself. The bite caused no more inconvenience than those I have received from alligators a month old.

The upper lips of the three-fingered siren are thin-edged and pendulous, extending from the commissure of the jaw to a point nearly opposite the nostril on either side, where they merge into the rounded snout. The lower lips do not meet in front by a centimetre. They are likewise thick and sharp-edged, overhanging the common integument of the lower jaw, and originating posteriorly within the commissure and beneath the upper lips. Minute glandular openings are seen on the head above, and in the maxillary space beneath, symmetrically arranged in rows, as on other parts of the body. We find the gill-clefts with two obliquely placed lips, with which they can be closed, the anterior one being the larger. The internal openings to the gill-clefts are far back in the pharynx, nearly opposite the rudimentary and partially cartilaginous larynx, which latter communicates directly with the superior extremities of the membranous pulmonary air-passages. A pair of normal lungs are among the most exquisite of structures in any vertebrate. Here they are particularly beautiful, being very long, cylindrical in form, extending far down into the abdomen, to terminate in pointed extremities. The right is thirteen centimetres longer than the left, and is carried nearly down to a point opposite the cloaca. From one end to the other, the alimentary tract is nearly or quite a straight tube. The oesophageal portion is rather small and tubular, with a few circular constrictions in its lower third. This division soon dilates into a spindle-shaped stomach of some size, which, in the specimen before me, is fourteen centimetres below the pharyngeal aperture. Below this last dilation the intestinal tract is carried straight to the cloaca, or rectal enlargement, into which the urinary and genital organs open. A very peculiar feature is noticeable in the circular constrictions that occur in the intestine at irregular intervals along its length. Very dark in color, the many-lobed liver is about twenty-six centimetres long, and covers at its lower tenth, or thicker extremity, an ellipsoidal gall-bladder of no small size. Many features of interest and importance present themselves in the circulatory and renal systems; but our space will not permit us to enter upon them here, as we have something to say about the osteology of Muraenopsis. Among other organs, a well-developed pancreas is to be observed; and the Wolffian bodies are present, and their dilated upper extremities are about opposite the lower end of the liver.

The tongue in this siren is in an extremely rudimentary stage of development. I will close this brief sketch of the anatomy of the soft parts — yet it can hardly be termed a sketch, for many structures have not even been alluded to — by calling the reader's attention to the remarkable length of time that nervous excitability, if I may apply such a term to the phenomenon, was kept up. My specimen was killed with chloroform. That of itself took a long time, forty minutes or more; but what is this, compared with the fact that its heart continued to pulsate in good rhythmical time during three hours and a half of my operations, and after the most extensive dis-

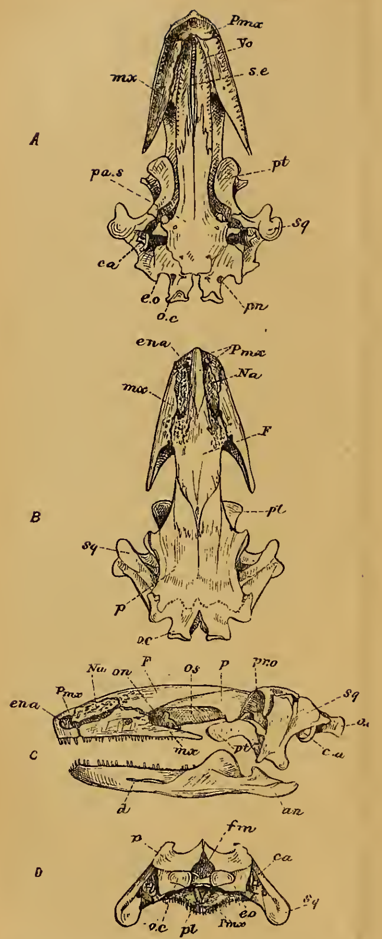


Fig. 2.—Dorsal, ventral, lateral, and posterior views of the skull of Muraenopsis tridactylus (life-size), respectively represented in A, B, C, and D, where like lettering has the same indication in each view. *Pmx*, premaxillary; *Vo*, vomer; *mx*, maxillary; *s. e*, splen-ethmoid; *pa. s*, parasphenoid; *pt*, pterygoid; *sq*, squamosal; *ca*, columella auris; *e. o*, exoccipital; o. c, occipital cordyle; *pn*, foramen for exit of pneumogastric and glosso-pharyngeal nerves; *ena*, external nasal aperture; *Na*, nasal; *F*, frontal; *p*, parietal; *on*, foramen for the passage of of the orbito-nasal nerve, the first division of the fifth pair, to the rhinal cavity; *os*, orbito-sphenoidal region; *pr. o*, pro-otic; *d*, dental element of mandible; *an*, angulae; *fm*, foramen magnum; *pl*, roof of the mouth.

sections had been made? And four hours and a half after, when all the organs had been removed, and inroads made upon the trunk, this creature would still writhe vigorously by simply pinching his tail, or close his jaws like a vice in a way that would put the hardiest of eels to shame, and crush any claim the latter might have in standing at the head of the list of those animals most tenacious of life. We find the cranium of Muraenopsis very thoroughly ossified, and many of the sutures observable only after close inspection. The teeth are of the pleurodont type, and may be seen in all stages of development in the deep grooves that exist in the mandible, the maxilla, the premaxilla (which usually supports twelve), and the entire inner margins of the descending plates of the vomers, which meet each other anteriorly (fig. 2, A). A long, slender, sphen-ethmoid is inserted between these last bones, quite distinctly seen on the inferior aspect.

The premaxilla throws backward a nasal process that overlaps the frontals above, and passes between the nasals. These latter segments are very much honeycombed and grooved, — a characteristic which is adopted by the anterior extremities of the frontals and the upper parts of the maxilla on either side. The coronal suture is seen beyond, a demi-lozenge shaped and elevated plate, developed by the united frontals, directed backward (fig. 2, B). Each outer margin of the parietal region is raised into a curling crest, as if pushed up by the unusually large squamosals, which lend to the lateral aspect of the skull of this creature such a massive appearance. As in other Urodela, a large columella auris is seen on either side, external to the extensive processes that project backward, to bear the occipital condyles (fig. 2, D). A pro-otic is well developed; but it is difficult to determine in the adult cranium whether a separate epiotic and opisthotic exist or not, though I am strongly inclined to think they do not. The pterygoids are completely ossified, and quite extensive, horizontally flattened, and curved plates of bone, their anterior extremities being prolonged with a fibrous tissue to form the floors of the orbits. The lower maxilla is very deep and solid; and, although the meeting of the dentary elements anteriorly is quite extensive, the symphysis is not firm. Nearly the entire basicranial region is occupied by the wide-spreading and anteriorly produced parasphenoid (fig. 2, A), which, with its serrated margin, articulates with the parallel vomerine plates beyond.

We have presented us for examination in

the hyoidean apparatus (fig. 3) two reniform hypo-hyals in cartilage, surmounted by a triple piece of the same material that occupies the usual site of the glosso-hyal. In the median line we have a thoroughly ossified basi-hyal; while curved bony cerato-hyals, with expanded cartilaginous anterior ends, are suspended from the hypo-hyals. Four branchial arches are represented; the first pair being long, curved bones, and the remaining ones cartilage. The gill-clefts open to the rear of the last pair on either side.

The spinal column of an adult Muraenopsis contains one hundred and ten well-ossified vertebrae. The second and third of these have suspended from their transverse processes free ribs, of which the anterior pair is the larger. A strongly marked intercondyloid process is formed between the two concave facets on the anterior aspect of the atlas. As a rule, all these vertebrae, except the first and the extremely rudimentary caudal ones, are of the amphicoelous type, with lofty neural spines,—far-spreading transversed processes that become horizontally broadened in mid-spinal region,—and with well-marked zygapophysial processes to link the series together. None of these vertebrae are modified to form a sacrum in con-

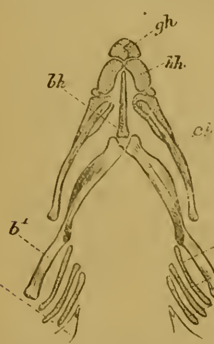


FIG. 3.—Hyoidean and branchial apparatus of Muraenopsis tridactylus; life-size; dotted parts in cartilage; *gh*, rudimentary glosso-hyal; *hh*, hypo-hyal; *ch*, cerato-hyal; b^1, b^2, b^3, and b^4, branchial arches; *gc*, gill-cleft.

nection with the pelvis in the precaudal region; beyond which, each segment throws down parial hypapophysial processes, which are not lost, as we proceed backwards, until we arrive at the ultimate nodules that complete the tip of the tail.

In my specimen the thirty-third and thirty-fourth vertebrae have coalesced in the most remarkable manner, forming one bone, with nearly all the parts double. The appendicular skeleton is represented by extremely rudimentary shoulder and pelvic girdles, supporting equally feebly developed limbs, with their segments arranged as seen in fig. 4. We find

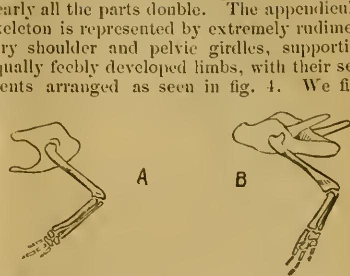


FIG. 4.—A, right fore-limb and rudimentary shoulder-girdle; B, right hind-limb and rudimentary pelvis, both slightly enlarged, of M. tridactylus. From dissections by the author.

the carpus has three cartilaginous elements in its structure,—two in the proximal row, and only one in the distal. This number is increased by an additional segment in the tarsus, which has two elements in each row, articulating with the digits, as shown in the figure.

Osseous tissue of an elementary character may be deposited in the humerus, the femur, and certain points in the pelvis, more particularly the projecting rod that appears to represent the pubic bone; otherwise all this part of the skeleton in our siren remains in cartilage throughout life.

R. W. SHUFELDT.

THE GREAT TERMINAL MORAINE ACROSS PENNSYLVANIA.[1]

AFTER describing the investigations which elsewhere had demonstrated the existence of a true terminal moraine to the glacier covering north-eastern America, the author stated, that having obtained the aid of the geological survey of Pennsylvania, and, during a portion of his work, the assistance of Prof. G. F. Wright, he had been able to follow and define the southern limit of glaciation for the first time in a continuous line four hundred miles in length, and to find that it was everywhere marked by a remarkable accumulation of glaciated material, which, winding across mountains and valleys, from the lowlands of the Delaware to the great Alleghany plateau, was continuous from end to end, and formed a true terminal moraine.

There is a marked distinction between the glaciated portion of Pennsylvania and that region south of glacial action. Although the general topography of the two regions is alike, the varied superficial features due to glacial agencies, the far travelled and scratched bowlders, the smoothed and striated

[1] Abstract of a paper before the American association for the advancement of science, in Montreal, August, 1882. By Prof. H. CARVILL LEWIS.

rock-exposures, the unstratified deposit of till, the many kames, and especially the numerous glacier-scratched fragments and pebbles, — all these deposits are in strong contrast with those south of the moraine, where all the gravels are stratified and the pebbles water-worn, where the rocks are never polished or striated, but, on the other hand, often decomposed to a great depth, and where, except near the seacoast, wide stretches of the more elevated regions are perfectly free from all drift.

The method employed in discovering the line of the moraine was to zigzag along its course from the glaciated into the non-glaciated region, and *vice versa*, going each time far enough on the one side to be fully satisfied of the absence of glaciation, and, on the other, to find undoubted traces of its action.

Nowhere south of the line of the terminal moraine had he found any traces of glacial action, *all statements by other geologists to the contrary notwithstanding*. When typically developed, the terminal moraine is characterized by peculiar contours of its own. A series of hummocks, or low conical hills, alternate with short straight ridges, and enclose shallow basin-shaped depressions, which, like inverted hummocks in shape, are known as *kettle-holes*. Large bowlders are scattered over the surface; and the unstratified till which composes the deposit is filled with glacier-scratched bowlders and fragments of all sizes and shapes. The average width of the moraine is about one mile.

At many places, however, the limit of glaciation is marked merely by an unusual collection of large transported bowlders. This is especially the case in front of a high mountain range which has 'combed out' the drift from the ice.

The general course of the moraine across Pennsylvania was defined as follows: appearing first in Northampton county, a mile below Belvidere, at latitude 40° 49′, it winds in a great curve, first westward and then northward, reaching the base of the Kittatinny Mountain, three miles east of the Wind-Gap.

Ascending to the top of the Kittatinny Mountain, sixteen hundred feet high, the moraine crosses the great valley between the Kittatinny and the Pocono, and then swings sharply back and around Pocono Knob, immediately afterwards to ascend the steep face of the mountain to the wide plateau on top, twenty-one hundred feet above the sea. Crossing this in a fine curve, and heaped up in an immense accumulation, it goes first north and afterwards west, reaching the gorge of the Lehigh River, some ten miles north of Mauch Chunk. It crosses the gorge at Hickory Run, and, without swerving from its general north-western course, ascends mountain range after mountain range, descends to the valley of the east branch of the Susquehanna, and crosses the river at Beach Haven.

Then, following the base of Huntington or Knob Mountain, it finally ascends it, and crossing its summit, at a height of fifteen hundred feet above the Susquehanna just below, descends the north slope of the mountain to the broad, undulating valley to the north. Taking a northerly course, it follows up on the east bank of Fishing Creek to the North or Alleghany Mountain, enters Lycoming county, passes westward along the base of the mountain, crossing in its course the Muncy and Loyalsock creeks, and then, near the village of Loyalsock, turns at right angles, and ascends the mountain.

Having reached the summit of the Alleghanies, over two thousand feet above the sea, it passes west through a wild, wooded region nearly as far as Pine Creek, where it begins a nearly straight north-westward course through the south-west corner of Tioga county, and the north-west part of Potter. In the high ground of Potter county, the moraine crosses a great continental watershed, from which the waters flow into the Gulf of Mexico, Lake Ontario, and Chesapeake Bay. The moraine is here finely shown at an elevation of twenty-five hundred and eighty feet, being higher than elsewhere in the United States.

It now enters the state of New York in the south-west corner of Allegany county. Passing still north-west, and entering Cattaraugus county, it twice crosses the winding course of the Allegheny River, east and west of Olean; then trending to a point five miles north of Salamanca, in latitude 42° 15′, it forms a remarkable apex, whence to the Ohio line its course is south-west. Turning at right angles to its former course, the moraine passes south-west through the south-east corner of Chautauqua county, and, keeping approximately parallel to the course of the Allegheny River, re-enters Pennsylvania in Pine Grove township, Warren county. It crosses the Conewango River seven miles north of Warren; then trending west, still at a general elevation of nearly two thousand feet above the sea, it crosses one gorge after another, and forms a line separating not only the glaciated from the non-glaciated region, but also the cultivated from the uncultivated and densely wooded region. It crosses the south-east corner of Crawford county, skirts the north-west and west boundary of Venango county, crosses Beaver River eight miles south of New Castle, and, traversing the extreme north-west corner of Beaver county, crosses the Ohio state line in the middle of Darlington township, thirteen miles north of the Ohio River.

The moraine thus leaves Pennsylvania at precisely the latitude at which it entered the state; and, if a straight line were drawn across the state between these two points, the line of the moraine would form with it a nearly right-angled triangle whose apex was a hundred miles distant perpendicularly from its base. The total length of the moraine, as here shown, is about four hundred miles. The moraine crosses the Delaware at an elevation of two hundred and fifty feet, the Allegheny at an elevation of fourteen hundred and twenty-five feet, and the Beaver at an elevation of eight hundred feet, above the sea, or two hundred and twenty-five feet above Lake Erie. Upon the high lands it rises higher by a thousand feet or more.

Coming to the details of the moraine, many of which are of great interest, reference was made to its fine development in Northampton county, west of

THE GREAT TERMINAL MORAINE ACROSS PENNSYLVANIA. by H. CARVILL LEWIS.

The Glaciated area is shaded

Bangor, where it forms a series of hummocky hills, which, a hundred to two hundred feet in height, and covered with transported and striated bowlders, rise abruptly out of a clayey plain to the west. Glacial striae upon exposed surfaces near Bangor point south-west, or towards the moraine. After following the moraine to the base of the Kittatinny Mountain, it became of great interest to know whether a great lobe of ice descended from New Jersey along the lower side of the mountain, or whether a tongue projected through the Delaware Water-Gap, or whether the glacier, even so close to its southern limit, came bodily over the top of the mountain, unchecked by it, and unchanged in its course. The last, the most improbable of these hypotheses, and certainly the least expected by the author, proved to be undoubtedly the true one. The author had been able to show that the moraine crossed the mountain near Offset Knob; that large bowlders, derived from lower elevations several miles northward, lie perched all along the summit, fourteen hundred feet above the sea; and that, as shown by the numerous striae on the northern slope of the mountain, running *up-hill*, the glacier moved diagonally up and across the mountain, uninfluenced in any way by the presence of the Water-Gap, and finally came to an end in the valley south of the mountain, as marked out by the terminal moraine. Huge bowlders of fossiliferous limestone, sometimes thirty feet long, were torn by the ice from their parent strata in Monroe county, on the north side of the mountain, lifted up a thousand feet, carried across the mountain, and dropped finally in the slate valley of Northampton county. The author had found one of these limestone bowlders upon the very summit of the mountain, where the jagged sandstone rocks had combed it out of the ice during its passage across. The journeys of these bowlders were short; but that of a well-rounded bowlder of Adirondack syenite, which the author had found in the same county, was about two hundred miles.

Another interesting point is in Monroe county, upon the summit of Pocono Mountain, over two thousand feet above the sea, where a great ridge of moraine hills twelve miles long, one mile wide, and a hundred or more feet high, composed of unstratified till, and bearing numerous bowlders of Adirondack gneisses and granites, rises out of the level, sandy plain of the Pocono plateau, and sweeps around from Pocono Knob into Carbon county. Known locally as 'Long Ridge,' its origin had never before been suspected. It encloses remarkable little 'moraine lakes' without inlet or outlet, and is heaped up into just such conical hills as may be seen in the moraine in southern Massachusetts. Nothing can more clearly show the continuity and uniformity of action of the great glacier than the identity of its moraine accumulations at such remote points.

In fact, the course of the moraine, as it winds from the top of the Kittatinny Mountain down to Cherry valley, and then up again on to the Pocono, is a complete vindication of the glacial hypothesis. It is in no sense a water-level, nor could it have been formed by floating ice. No other cause than that of a great glacier could form a continuous accumulation of glaciated material which contains no evidences of water-action, and which follows such a course. Neither on the mountains nor in the valley does the moraine rest against any defined barrier, as would be the case were it a shore-line.

The kames of Cherry valley, fine examples of which appear south of Stroudsburg, are interesting relics of sub-glacial water-action. They are composed of stratified water-worn gravel, having often an anticlinal structure, and as a series of conical hills and reticulated ridges, enclosing 'kettle-holes,' form conspicuous objects in the centre of the valley. They appear to have been formed by sub-glacial rivers, which, flowing from the moraine *backwards*, under or at the edge of the ice, emptied into the Delaware valley. They thus probably differ in origin from the longer kames in New England, and other regions more remote from the edge of the glacier.

The glacier had produced very slight effect upon the topography of Pennsylvania. It neither levelled down mountains nor scooped out cañons. The glacier passed bodily across the sharp edge of the Kittatinny Mountain without having any appreciable effect upon it, the glaciated part of the ridge being as high and as sharp as that part south of the moraine.

In describing the course of the moraine across Luzerne county, the author showed that it crossed several mountain chains in succession, by each of which it was locally deflected northward. At the point where the terminal moraine crosses Buck Mountain, in a line diagonally across the mountain, the moraine was so sharply defined that he was able to stand with one foot upon the glaciated and the other upon the non-glaciated region. It was interesting to find, that in *front* of a mountain chain, such as Huntington Mountain or the Alleghany Mountain, the moraine was poorly developed, as though the mountain had 'combed out' the drift from the ice.

He described an instructive portion of the moraine, where, three and one-half miles north-west of Berwick, it seems to abut against a high slate hill, which furnishes, therefore, a *section* of the end of the glacier. It shows that the extreme edge of the ice was here only about four hundred feet thick, and that, while the moraine and the scratched pebbles were carried along at the base of the ice, sharp fragments of sandstone were carried on top.

In speaking of the apex made by the moraine in New York, and of the high plateau region of Potter county, it was inferred, from the local influence already shown by the author to have been exerted by single mountain chains, that this region of high elevation had a decided influence upon the general course of the moraine.

Certain facts observed as to the gravel-ridges of the Allegheny River rendered it probable that the river flowed under a tongue of the glacier. ten miles broad and two miles long, through a sub-glacial channel, at the time of its greatest extension near Olean. He described a great natural dam across the valley of the Great Valley Creek, near Peth, where the moraine stretches across the valley from side to side: and he spoke of the contrast between the numerous drainage valleys which drained the waters of the melting ice into the Allegheny River, and those valleys which took their rise south of the moraine, and were free from all drift.

After giving some details of the western lobe of the ice-sheet, and dwelling upon the agricultural significance of the moraine, he spoke of some curious deposits of glaciated material which occurred in a narrow strip of ground immediately in front of the moraine, and which he had named the 'fringe.' These deposits consisted of bowlders of Canadian granite, and other rocks, which he found perched upon the summits of hills, sometimes as far as five miles in front of the moraine, though never farther. This glacial 'fringe,' confined to the western part of the state, was found to increase in width from two miles in Warren county to five miles on the Ohio line, and was at first a puzzling phenomenon. The hypothesis suggested was, that, like breakers on the seashore, the top of the ice overreached the lowest strata by the width of the 'fringe,' and that while the moraine marked the halting-place of the bottom of the ice, by which it was formed, the far-transported bowlders were carried on more rapidly in the top strata of the ice, and were dropped outside of the moraine to form the 'fringe.' It was stated that the striae in the western part of the state all pointed south-east, being at right angles to those in the eastern part of the state, but, like them, pointing always towards the moraine.

In conclusion, the author reviewed the more important facts discovered during his exploration of the line of the moraine, dwelling upon the character of the moraine where crossing river-valleys, the absence of proof of any tongues of ice down such valleys, the absence of glacial drift south of the moraine, the very slight erosion caused by the passage of the glacier, and especially upon the deflections, large and small, in the line of the moraine, which were inexplicable on any other hypothesis than that the moraine now described was pushed out at the foot of a continuous ice-sheet of immense extent.

LETTERS TO THE EDITOR.

Change of birds' notes.

For some years it has been known to many about here, that in one locality the cardinal bird (Cardinalis virginianus) has been in the habit of imitating the notes of the whippoorwill (Antrostomus vociferus). From articles I have read from time to time in various scientific journals, I infer that it is not generally known that birds ever, in the wild state (especially cardinalis), change their song. I therefore thought it well to report this case. I have in several instances known this bird to change its song, under confinement, for one entirely different; but this is the only case I have ever known where such a thing has occurred in the wild state. I have known of this case for about ten years.

F. O. Jacobs.

Newark, Licking county, O.

St. David's rocks and universal law.

The article with the above heading in Science of June 15, by Dr. M. E. Wadsworth, has just come under my observation; and, as it refers to questions which have arisen chiefly in consequence of my researches among those rocks, I shall deem it a favor if you will allow me space in Science for a few remarks in explanation. Professor Geikie's paper was written with, as he states, 'a sense of duty' to 'defend the views of his predecessors;' and it is perfectly certain, from the hasty manner in which the work was gone over by Professor Geikie and his two assistants, that the object was to vindicate the work of the Geological survey of thirty or forty years ago, rather than to apply the knowledge gained by the work of many independent observers since that time to correct the errors well known to have been committed by the surveyors, which remain as blots on the maps even now issued by the Geological survey. In the district of St. David's, these maps show a great intrusive mass passing under the city of St. David's, about eight miles in length, and with an average width of about a mile. The southern portion is called syenite, and the other felstone. The rocks lying along the north-western edge for about a mile in width are colored as altered Cambrian, presumably as the result of the intrusion; but on the south-east the rocks of the same age are supposed to be in contact with the mass in an unaltered condition, and without even a line of fault to separate them. These appearances were curiously anomalous if true: hence I felt it necessary to go very carefully into the question. My large acquaintance with the district, and the knowledge I had obtained in my explorations among the lower fossiliferous rocks of the area, enabled me to do this with some advantage. I had also, from time to time, much valuable assistance from Professors Harkness, Hughes, and Bonney, and from Mr. T. Davies of the British museum, Mr. Tawney, etc.

I found that under the same name, rocks of very different characters had been grouped together. The so-called syenite ridge was seen to consist in part of granitoid rocks, but also of quartz-felsites, of hälleflintas, of breccias, and of porcellanites freely traversed by intrusive dikes of various kinds. The so-called metamorphic Cambrian on the north-west was soon discovered to be an entirely distinct series from any Cambrian rocks known in the district, or, indeed, anywhere in Wales, and to be largely made up of volcanic rocks; and the basal Cambrian conglomerate, as marked on the survey-maps, was shown to overlie the granitoid, the quartz-felsite, hälleflinta, and the volcanic schistose and brecciated series unconformably, and to be mainly made up of fragments derived from those series. From the examination of the conglomerates also, it was seen that there were distinct evidences of their having been deposited along old coast-lines, and that their materials varied with the rocks upon which they reposed; also that these pre-Cambrian rocks must have been much in the condition in which they are now found, before the Cambrian conglomerates were deposited upon them. Curiously, also, I found that many of the masses colored as intrusive greenstones on the survey-maps were highly *acid* rocks, and others indurated volcanic ashes of pre-Cambrian age. Indeed, nearly all the so-called intrusive masses marked so abundantly on the survey-map among the older rocks in the St. David's area have been proved beyond doubt to be the result of erroneous observation; and yet we are told by the present director-general that little or no change is required in these maps, and that he feels it his duty to 'defend the views of his predecessors' as there indicated. There is a still larger area of the Dimetian rocks about ten miles to the east of St. David's; and there, as at St. David's, these granitoid rocks underlie the lowest Cambrian beds without producing the slightest alteration in the latter. Indeed, I have now found no less than six areas in Wales where typical Dimetian granitoid rocks occur under the Cambrian or pre-Cambrian rocks; and in neither of these areas, though several excellent observers have, in addition to myself, searched the boundaries carefully, have we found the slightest indications of their being intrusive in those rocks, though they are all colored as intrusive rocks in the survey-maps. In several of these areas the fact that they must be pre-Cambrian rocks is rendered perfectly certain, as large fragments of the granitoid rocks in exactly the same condition in which they are now found occur in the basal conglomerates of the Cambrian. In one area only, in Wales, have I found Dimetian rocks entirely surrounded by rocks newer than the Cambrian; and here the Llandovery conglomerates and sandstones repose upon them, and are largely made up of materials derived from the Dimetian. In the other areas newer rocks than the Cambrian are found occasionally in contact with limited portions of the Dimetian exposures; but these effects are clearly seen to have been produced by faults.

In his paper to the Geological society, referred to in Science, Professor Geikie maintained "that the 'Dimetian group' is an eruptive granite which has disrupted and altered the Cambrian strata, even above the horizon of the supposed basal conglomerate." The evidence adduced to support this view was from a section at Ogof-Llesugn, where, as he supposed, "the conglomerate had been torn off and enclosed in the granite, and has been intensely indurated so as to become a sort of pebbly quartzite." Professor Hughes and myself, along with a number of other competent observers, have since examined this spot; and we found that the conglomerate lies quite loosely upon the Dimetian, that at almost every point we could pass our hand between the conglomerate and the granitoid rock, and that the Cambrian conglomerate had no change whatever induced in it beyond that common to it in all parts of the district. Two other sections were mentioned, and drawings exhibited to show the 'Dimetian' intrusive in the Cambrian, and as having eaten deeply into the series at Porthclais. These sections I knew perfectly well, at the time, to be in the lines of faults; but for greater satisfaction I asked Professor Hughes and party to re-examine these with me. The result proved that I was entirely right, and that Professor Geikie and his assistants had mistaken a junction produced by well-marked faulting for an intrusion, and the beds which he supposed had been eaten away had simply been dropped by the fault. He could not produce a single specimen showing contact alteration between the granitoid (Dimetian series) and overlying rocks. His evidence, therefore, fails utterly, on examination; and the pre-Cambrian age of the granitoid rocks of St. David's is rendered, if possible, more than ever certain. An attempt was made to show that the quartz-porphyries which I had pointed out as being intrusive in the Pebidian rocks, which alter the rocks in their immediate vicinity, were just such rocks as might be apophyses of the 'granite,' but, with a curious want of knowledge of the fact that these quartz-porphyries are common to many other parts of the area far distant from the granitoid series, that they also actually in some places cut across the latter.

As Professor Geikie did not spend the time necessary to examine the area where the Arvonian rocks are chiefly exposed, but hastily arrived at the conclusion, without seeing them, that the hälleflintas, breccias, and porcellanites must be intrusive felstones, I need scarcely refer to Professor Geikie's views on this point. I shall refer fully to this question in my paper. in reply, to the Geological society. I may, however, mention, that I exhibited a series of magnificent breccias from this group, and showed large masses of the Cambrian basement conglomerates from Ramsey Island, consisting almost entirely of the rocks of the Arvonian group upon which they repose. The latter are colored in the survey-map as *intrusive* in beds high up in the Silurian (fossiliferous Arenig).

The Pebidian, Professor Geikie says, 'forms an integral part of the Cambrian system.' He acknowledges that it underlies the Cambrian conglomerate, but says the latter rests quite conformably upon the former. In the survey-map these Pebidian beds are supposed to be Cambrian beds higher than the conglomerate, but altered by the so-called intrusions. Here, therefore, some modification of the map is acknowledged to be necessary. Had Professor Geikie and his assistants used ordinary care in examining these conglomerates, they would have seen also that they are constantly in contact with different members of the underlying rocks, that they lie unconformably on the edges of those beds, and also that they are very largely made up of the rocks below.

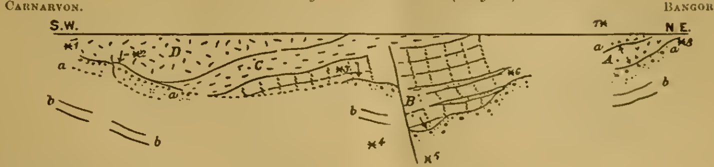
Professor Geikie did not refer to North Wales in his paper; but as the facts are, if possible, clearer there than in South Wales, I may be allowed to call the attention of the readers of Science to some sections just published by the Geologists' association of London, preparatory to the visit to be paid by the members to Carnarvonshire and Anglesey, July 23–28. These sections show in a very clear manner how the Cambrian conglomerates creep over the Dimetian, Arvonian, and Pebidian rocks in that area. The rocks of the first two and lowest groups are in that area, as at St. David's, colored as intrusive rocks in the survey-maps, and the last as altered Cambrian and Silurian rocks.

The sections have been prepared by Prof. T. McK. Hughes (Woodwardian professor of geology at Cambridge, and formerly of the Geological survey), who has carefully worked out the geology of this district. He and I were the first to point out, in the year 1877, the similarity of the conditions exhibited here to those at St. David's; and since then he has devoted much time to the elucidation of the facts bearing upon the questions in that area.

In a diagram (no. 1) he shows how the basement conglomerate of the Cambrian, between Bangor and Carnarvon, creeps over no less than four sub-groups of the archean rocks: viz., at Bangor, over the Bryniau beds (Pebidian); at Brithdir, the Dinorwig beds (Arvonian ?); at another part farther south, the Crug beds (upper Dimetian); and at Tut Hill, the Carnarvon beds (lower Dimetian). In section 2, the unconformable overlap of the Cambrian over the Pebidian near Bangor is clearly shown; and in no. 3, a diagram section showing the sequence of the rocks from Carnarvon to Snowdon, the basement beds of the Cambrian are shown rolling over the Carnarvon and Dinorwig groups at different points.

Altogether, the evidence afforded by these sections is of the most conclusive kind; and it seems impossible to believe that the surveyors, when they have seen and examined these sections, and have had more experience with the Welsh rocks, can still cling to the antiquated faith that all these pre-Cambrian rocks

1.—Diagram plan showing how the Cambrian basement beds creep over the various divisions of the archean between Bangor and Carnarvon (Hughes).



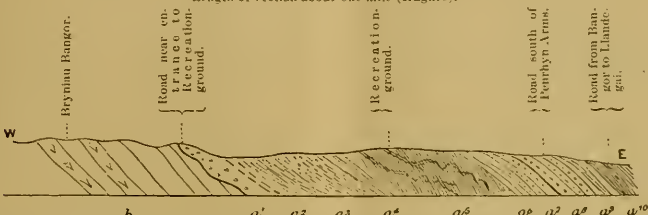
Cambrian.
b, Sandstone and shale of Cambrian.
a, Conglomerate and grit of Cambrian basement beds.

Archean.
A, Bryniau beds / B, Dinorwig beds } Bangor group (= Pebidian, etc.). | C, Crug beds / D, Twt beds } Carnarvon group (= Dimetian).

*1, Twt Hill; *2, Yseyborwen; *3, Careggoch; *4, Llandeiniolen; *5, Tymawr; *6, Brithdir; *7, Hendrewen; *8, Bryniau Bangor.

2.—Diagram section east and west across Bryniau Bangor.

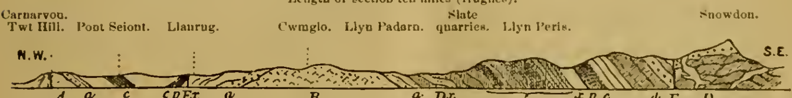
Length of section about one mile (Hughes).



b, Bangor beds (upper Pebidian); a^1, Conglomerate and sandstone (basement bed of Cambrian); a^2, Sandy mudstone; a^3, Finer felspathic mudstone; a^4, Pale green felspathic mudstone; a^5, Cleaved and contorted felspathic mudstone; a^6, Purple and green fine mudstone and slate; a^7, Fine sandy flags, like the Bray beds, purple, and here and there green, passing up into brown; a^8, Even-bedded thin gray sandstones; a^9, Banded flags, passing up into a^{10}, Black slates.

3.—Diagram section showing the sequence of rocks from Carnarvon to Snowdon.

Length of section ten miles (Hughes).



Archean.
A, Carnarvon group (Dimetian); B, Dinorwig group.

a, Conglomerate and sandstone (basement bed of Cambrian); b, Lower and middle portions of Cambrian, not subdivided, but probably including Harlech, Menevian, Lingula flags, and Tremadoc beds; c, Arenig; p, Pisolitic iron ore; d, Bala group, with subordinate volcanic beds; F, Faults; x, Broken ground; D, Dikes.

are merely intrusive masses or altered beds of Silurian and Cambrian age. The basal conglomerate in this area consists in places almost entirely of quartz-felsites, at other points of a mixture of granitoid (true Dimetian) and felsite rocks, and in some cases of schists. I may further mention with regard to the crystalline schists in Anglesey and in Scotland, supposed by the Geological survey also to be of Cambrian and Silurian age, that the recent researches of Bonney, Callaway, Lapworth, and myself, tend to make it certain that they are all, like the similar rocks in America described by Dr. Sterry Hunt and others, of pre-Cambrian age. Henry Hicks.

Hendon, N. W., London,
July 5, 1883.

Silurian strata near Winnipeg.

Presuming that it may be of interest to some readers of Science to read something on the geology of a locality near Winnipeg, I take pleasure in furnishing information, hitherto unpublished, concerning an outcrop of Silurian strata in this part of the north-west. This interesting exposure occurs a short distance from Selkirk, situated some twenty-one miles north of Winnipeg on the Canadian Pacific railway, and near the Red River.

At this place a quarry was opened about a year ago, which, on examination, affords many attractions to a student of science. Fossils belonging to some sixteen species are readily obtained, not only in the solid rock, but also in the innumerable chippings that lie scattered about the quarry.

The rock is magnesian limestone, dresses readily, and, when burnt, supplies excellent lime. Stone from this place is shipped by rail to Winnipeg, where it is used for ordinary and ornamental building-purposes. Many of the fossils being in the form of casts, they frequently interfere with the successful dressing of the stone. About four feet of drift material overlies the rock; but at another quarry lately opened, nearer the river and a short distance farther north, the drift material attains a thickness of twenty feet. The rock is much the same, but apparently not so fossiliferous.

In the quarry first referred to, the remains of corals belonging to the genera Alveolaria, Halysites, and Zaphrentis, are very numerous. Some specimens obtained bear a close resemblance to the genus Favosites. Another group of very common fossils are representatives of the genera Orthoceras, Endoceras, Ormoceras, and Cyrtoceras.

An excellent specimen measuring eight inches in diameter, with three whorls, was found. The specific characters are much obliterated, but in general outline and appearance it bears a close resemblance to Trocholites ammonius of the Trenton.

Several imperfect specimens of Trilobites were found. One appears to be a member of the genus Illaenus. Fragments of Stromatopora are common, showing in all cases distinct lamination, and, in several, well-defined oscula; while in a few, conical elevations can be observed. The specimens obtained were found among the fragments of rock scattered about the quarry; but the characters of all are exceedingly uniform. The largest obtained measures 7 inches across, 5 in depth, and 2 in thickness. The laminae are well marked, numbering four to the line. They present a wave-like appearance, there being three crests in the section under examination. At the summit of each crest a large aperture is observed. Viewing the specimen from the top, six of these oscula are seen, all about the same distance apart. As yet, I have discovered no rods or pillars present; but there is no question regarding the presence of well-marked laminae and oscula.

I have read carefully the description of the species S. tuberculata, S. perforata, S. granulata, S. mammillata, and S. ostiolata, of Nicholson, and S. concentrica of Goldfuss, and none seem to embrace the species from this quarry. If any reader of Science can suggest the species to which this interesting fossil from Selkirk belongs, he will confer a great favor upon the writer. J. Hoyes Panton.

Pre-Bonneville climate.

In a critical notice of my preliminary report on Lake Bonneville (Science, no. 20), Mr. Davis points out that a certain conclusion as to the history of the basin is not sustained by the phenomena described. Since reading his comment, I have not been able to consult my text; but, if memory serves, his restriction is fully warranted. Still, the conclusion is not of necessity overthrown; for it is based in part on omitted data, the report aiming to present only an outline of the subject. Now that the matter is up for discussion, it may be well to indicate these.

The facts set forth are as follows. Above the Bonneville shore-line the topographic forms are those produced by sub-aerial agencies. Below the shore-line the details are of sub-aqueous origin, but the larger features are sub-aerial in type. Especially are the great alluvial cones constituting the pediments of some of the mountains continued beneath the old water-margin, their surfaces being lightly etched and embossed by lake agencies. Evidently these alluvial cones are of pre-Bonneville date; and evidently, too, the goal of drainage — 'the base level of erosion' — was lower when they were built than during the Bonneville epoch.

The questioned conclusion is, that the emptiness of the basin during the long pre-Bonneville, alluvial-cone epoch was due to aridity. Mr. Davis acutely perceives, that the adduced phenomena comport equally well with the alternative hypothesis that the pre-Bonneville condition of the basin was one of free drainage to the ocean, the present continuity of the basin's rim having been instituted either at or just before the beginning of the Bonneville epoch.

On this hypothesis, the place at which the drainage of the basin was discharged must have acquired the peculiar configuration of a river-channel; and since, as our observations show, alluvial accumulation has not been great in the region during Bonneville and post-Bonneville time, vestiges of this channel should remain. The fact that they have not been found goes far to show that they are not visible; for intelligent search has been made for them, our eyes having been trained for their recognition by the discovery of pre-Bonneville channels *within* the basin. All the low passes of the enclosing rim have been scrutinized. At whatever points, then, earlier drainage systems have intersected this rim, the channels appear to have been obliterated by the erosive and constructive agencies of land sculpture.

Again: the principal plain of the Bonneville basin is at heart mountainous. Its surface is level only because the alluvial mountain bases are deeply buried by later deposits. Of the nature of these deposits we know little more than that the uppermost is lacustrine, the Bonneville layer concealing all else. The deposit representing the pre-Bonneville or alluvial-cone epoch must be relatively heavy, and may be assumed to dominate in the determination of the general configuration of the plain. With the basin closed, a certain system of slopes would arise: with the basin open, there would arise a certain other system, definitely related to the point of discharge. The actual system of slopes is adjusted to the existing status, — a closed basin, with lacustral sedimentation.

Assuming that there was at some remote date a channel of outflow, and that the configuration of the plain was adjusted thereto, the period consumed in the obliteration of the one and the remodelling of the other must have been long as compared with the Bonneville epoch. The pre-Bonneville portion of the period — when the basin was closed, but contained no lake — was presumably characterized by a climate similar to the present.

The aridity of the pre-Bonneville epoch is one of the features associating the Bonneville history with glacial history; for, if it be disproved, the Bonneville flooding no longer demonstrates a climatic episode, and the apparent homology disappears. And the Bonneville oscillations have, of course, no climatographic value if they were orographically produced. It is well, therefore, to test thoroughly every link in the chain of evidence. G. K. Gilbert.

Nevada, July 15, 1883.

WARD'S DYNAMIC SOCIOLOGY.

III.

Mr. Ward presents a classification of the sciences differing from those proposed by August Comte and Herbert Spencer. The new classification is of great interest, and deserves especial mention. The classification of Comte was made prior to the great development of modern scientific research, and is imperfect. The classification of Spencer is, like much of his philosophy, a mixture of metaphysical speculation and positive knowledge. Does the classification of Ward meet the requirements of scientific philosophy?

He divides the subject-matter of all science into three parts, which he denominates the 'primary,' 'secondary,' and 'tertiary' aggregations. It is a classification of the objects of the cosmos by modes of aggregation. The primary aggregation is molecular, and gives an inorganic kingdom; the secondary is morphologic, and gives a biologic kingdom; the tertiary is sociologic, and is represented by human society.

A mountain is an aggregation of rocks, or geological formations, some of which may be crystalline, others detrital. It is an inorganic molar aggregate, and must fall into Mr. Ward's first class. But the earth itself is an aggregate of solids, fluids, and gases. Its solids are molar aggregates of detrital and crystalline rocks. These rocks at the surface are arranged in mountains, hills, and valleys, with intervening depressions filled with bodies of water, — seas, lakes, and rivers; and beneath, an unknown interior; and above, the atmosphere. The atmosphere is in motion. The water is carried into the air, and moves with it, and descends again upon the earth. The known solid portion of the earth is also in motion, rising and falling in its relation to the centre of the earth; while portions of the unknown interior of the earth are, by extravasation, coming to the surface, and the land portions of the earth are being carried by the waters into the sea.

Geology teaches us, then, that the earth is composed of interdependent parts; that the circulation of the air, of the waters, of the solids, and of the interior liquids is carried on by the action of the several interdependent parts; and the earth has been not inaptly compared by eminent geologists to a living or organized being. If we properly understand Mr. Ward, this aggregation also is to be relegated to his first class.

Again: the earth is one of a group of worlds composing the solar system, — the solar aggregation, composed of interdependent parts; and this aggregation is also to be included in the first class.

The inclusion of all of these modes of aggregation in the one class is tacit. He does not clearly set them forth, and his definitions are imperfect. It is difficult to understand from his discussion whether they were considered in his general scheme, or whether he would, if considering them, establish one or two more grand categories.

Again: psychology is included in the secondary aggregation as belonging to biology. As the term is now used by scientific men, 'psychology' includes a consideration of the biologic organ of the mind and its operations. Through these operations are produced languages, giving the science of philology; arts, giving the science of technology; societies, giving the science of sociology; and opinions, giving the science of philosophy. With Mr. Ward, philology, technology, and perhaps philosophy, are subordinate parts of sociology. Though he does not make direct statement to this effect, yet his presentation leads to this conclusion, in the same manner as his presentation of the subject of primary aggregation leads to the supposition that he intends to include molar and stellar aggregations therein.

Psychology has its biologic organ in the brain and nervous system; and mind is discovered in the lower orders of life, as well as in man. The genesis of psychology is manifestly in biology. In like manner, the organs of speech, active and passive, alike in oral, sign, and written language, are biologic; and language is also found in the lower orders of life. Language, therefore, has its genesis in biology. In the same manner, the organs of the arts are biologic; and rude arts are discovered in the lower orders of life. Technology, therefore, has its genesis in biology. The first step in sociologic organization is the biologic differentiation of the sexes, giving husband and wife, parent and child; and rude social organization is also found in the lower orders of life. Sociology, therefore, has its genesis in biology. The same considerations that would lead to the relegation of psychology to biology would also lead to the inclusion of philology, technology, and sociology, and perhaps of philosophy.

Now, these five sciences are so bound together that the absence of one would void all. They are interdependent anp co-ordinate in such a manner that the evolution of one is dependent on the evolution of all. Language is a means of communication between individual minds. Discrete minds could not develop language: it is produced by many co-existing individuals of each of a long series of generations. Society and mind were necessary to its production. The arts are produced by many persons in the same manner as languages, and involve also the operations of mind; but the arts could not have been developed without the concomitant development of language, for art is built on art, and that which remains in art must pass from person to person and from generation to generation by means of language. The arts of absolutely discrete men could make no progress.

For the evolution of society, language is necessary for the intercommunication of thought. The interdependence of men as integral parts of bodies politic would be impossible without language; and sociologic organization is dependent upon the differentiation of human activities, or the division of labor, and is therefore dependent upon the development of arts or technology. Philosophy, or the science of evolving opinion, is the final product of the mind, and is therefore dependent upon psychologic evolution. It is dependent upon philology, for language is the mould of thought, and determines its form. It is dependent upon technology, for by the arts men reach knowledge not otherwise attainable; and upon sociology, for it is the combined knowledge of many, accumulating through the generations.

Again: all that part of the evolution of psychology which distinguishes the human mind from that of the lower animals is due to the tertiary aggregation in the development of philology, technology, sociology, and philosophy. In philology the method of evolution is the survival of the economic in the struggle for expression; and the course of evolution is through the specialization of the grammatic processes, the differentiation of the parts of speech, and the integration of the sentence. The method of evolution in technology is the survival of the useful in the struggle to have; and the course of evolution is the employment of the forces and materials of nature for the benefit of mankind. The method of sociologic evolution is the survival of justice in the struggle for peace; and the course of evolution is the differentiation of the functions and organs of government, and the integration of tribes and nations. The method of evolution in philosophy is the survival of the true in the struggle to know; and the course of evolution is in the discernment and discrimination of phenomena, the relegation from analogic to homologic categories in classification, and the discovery of more and more complex sequences. In these psychologic sciences the struggle, i.e., the endeavor, i.e., the conation, is teleologic.

The primary method of psychologic evolution is the survival of the fittest in the struggle for existence, and is purely biologic. The struggling subject itself survives. The secondary or indirect method of psychologic evolution is by the agencies of the philologic, technologic, sociologic, and philosophic methods; and, combined, they constitute the successful struggle for happiness. All that part of the evolution of psychology which separates man from the lower animals is due to this secondary or indirect method, and is teleologic; and progress is due, not to the survival of the fittest of the struggling subjects, but to the survival of the object for which the struggle is made. These five sciences, therefore, constitute one group, through the fact that they belong properly to the tertiary aggregation of matter, and the further fact that the method or cause of evolution exhibited therein is radically different from the method or cause of evolution in biology. The five sciences are co-ordinate, reciprocal, and interdependent. As biology has its genesis through protoplasm and organic chemistry in the physical aggregation, so these five sciences of the tertiary aggregation have their genesis in biology, — in the biologic organs of mankind, and the beginnings of these sciences discovered among the lower animals.

Elsewhere Mr. Ward classifies phenomena in the manner shown in the table on the following page, which is copied from his work.

Of the four groups thus derived, the first, inorganic, corresponds to the group embraced in his primary aggregation; the second, organic, to the group embraced in his secondary aggregation, but excludes psychology, philology, technology, sociology, and philosophy. If we combine his direct and indirect teleologic phenomena into one group, the five great sciences which include the operations and products of the mind are thrown into one. Let the first, then, be called *physical phenomena* or phenomena of the primary aggregation, and the sciences which pertain thereto physical sciences; the second, *biologic phenomena* or phenomena of the secondary aggregation, and the sciences pertaining thereto biologic sciences. But what shall the third group be called? If the term psychology is used, it must be with a wider connoting than that which it has heretofore had. Psychology.

Phenomena are:

- Genetic; physical; unconscious: producing change through infinitesimal increments.
  - *Inorganic:* the result of physical or mechanical forces.
  - *Organic:* the result of vital or biological forces.
- Teleological; psychical; conscious: proceeding from volition and involving purpose.
  - *Direct:* proceeding according to the direct method of conation.
    - *Zoölogical:* as manifested by creatures below man.
    - *Anthropological:* as manifested by man. Domain of the social forces.
  - *Indirect:* proceeding according to the indirect method of conation.

Natural: taking place according to uniform laws, and produced by true natural forces; capable of prediction and modification.

Artificial: consisting of natural phenomena modified by the inventive faculty.

then, would include the operations of the mind, and the products, or results, of those operations. If we use anthropology, the term will not include the beginnings of psychology, philology, technology, and sociology, found among the lower animals; for they have mind, language, art, and society in a comparatively low form. On the other hand, anthropology has been used so as to include the biology of man. If we use sociology, following Comte, Spencer, and Ward, the term must include more than these authors design, and some other term must be selected for that differentiated science which forms one of the group of five, and which above has been designated as sociology. Altogether it seems better to use the term *anthropology*, which would then include psychology, philology, technology, sociology, and philosophy.

Mr. Ward does not relegate ethics to any place in his scheme. Moral science relates to that portion of human conduct in which the qualities of right and wrong inhere; and the moral quality depends upon the relations which exist between men and men: it is therefore a part of sociology; and the principal body of ethics at any time existing among a people is formulated as law, made by the court or the legislature. Mr. Spencer, in his essay on the classification of the sciences, gives it no place, but, in the elaborate scheme of philosophy embraced in his works, places it above sociology.

It may be asked, What place does logic take in the classification here proposed? The reply is, that the logic of the ancients has no place in science. To modern logic something else has been added; and this something else belongs to psychology. The logic of the ancients, and a large part of that of modern metaphysicians, is a system designed to discover truth by a form of words. If it be truthfully asserted that an object is white, no form of words can prove the truth of the assertion. If questioned, the questioner must perceive that the body is white in the same manner as it was perceived by the person making the assertion; and the assertor can only point out, i.e., demonstrate, the fact. And the same is true of any other fact, howsoever simple or complex. A truth or fact can be pointed out or demonstrated to the eye, or to the mind's eye, but cannot be proved by a logical form of statement. The idea of logical proof is a conception of a time when powers were occult; and logic divested of modern appurtenances is an occult art.

It would make this article too long to attempt to set forth fully the place of mathematics in this scheme; but quantitative relations, like qualitative relations, belong to all degrees of aggregations, to all complexities of phenomena, and to all stages of evolution; and, in the science of mathematics, relations of quantity are considered apart from other relations, and in the abstract.

Mr. Spencer, although he presents a classification of the sciences, does not use it in his philosophy of evolution, but practically uses the primary classification here set forth, under the terms 'inorganic,' 'organic,' and 'super-organic' evolution.

The defect in Mr. Ward's classification here pointed out seriously influences his presentation of the subject of dynamic sociology proper, appearing in the second volume. It also greatly narrows his view of the field of successful endeavor for organized society. Mankind has made progress, i.e., secured happiness, quite as much by the effort for peace and the establishment of justice as by the effort to know and the acquisition of truth. It can be shown in other and diverse ways that his view of successful human endeavor is philosophically narrow; and he sometimes uses the epithets of the pessimist in a manner unworthy the philosopher.

FRUIT-INSECTS.

Insects injurious to fruits. Illustrated with 440 cuts. By WILLIAM SAUNDERS. Philadelphia, *Lippincott*, 1883. 436 p. 8°.

THE author has enjoyed exceptional advantages for the preparation of the work he has undertaken. Not only has he been acquainted with the work of economic entomologists through his own participation in it, and as editor of one of our principal entomological periodicals, but for twenty years past he has been an extensive fruit-grower as well. He is thus entirely familiar with what is wanted, and has produced a practical book of considerable value. Not that it contains much that is original or of novel presentment: it is rather a plain and judicious statement of what is known, but accessible to few because scattered in periodical literature. One is surprised at the size of the book when he sees that no effort is made to fill it out with unnecessary matter: rarely are half a dozen pages given to any one insect, and more than two hundred and fifty harmful insects are discussed.

The insects are treated under the head of the plants they affect and the parts of the plant they attack, — an excellent method, first used in this country by Fitch. They are described in brief, untechnical language, almost invariably figured, and often in several stages; and the account of their injuries is followed by a short statement of the best remedies, with illustrations of the parasites or other natural foes which keep the insects more or less in check. The plants which receive most attention are the apple (64 insects, 127 pages), the grape (52 insects, 75 pages), and the orange (26 insects, 45 pages). Next after these in importance are the plum, pear, the various currants, the raspberry, and the strawberry, followed at a little distance by the peach; a few pages each suffice for the cherry, quince, gooseberry, melon, cranberry, olive, and fig.

The illustrations are familiar friends to entomologists, almost all of them having already done abundant service; but they are none the less valuable for the purpose of this work; and the paper on which they are now printed permits to many of them a respectability they must rejoice to attain after long familiarity with the crude workmanship of the various government presses under which they have been tortured. With a little more care in the printing, they would have shown at their best.

The only serious omission in the book is the absence of a systematic summary, or index, by which the insects of the same group attacking different plants should be brought together. This would the more readily serve to help the fruit-grower distinguish allied forms, and learn their different or similar habits. Such an index could have been so easily constructed, and would have occupied so little space, that its absence is the less excusable.

BREMIKER'S LOGARITHMIC TABLES.

Bremiker's Logarithmisch-trigonometrische tafeln mit sechs decimal-stellen. Neu bearbeitet von Dr. TH. ALBRECHT, professor and chief of section in the Royal Prussian geodetic institute. Tenth stereotype edition. Berlin, *R. Stricker*, 1883. 18+598 p. 8°.

BREMIKER'S six-figure logarithms were first published in 1852 with a Latin text and title: Nova tabula Berolinensis, etc. In 1860 a German edition was printed. Both these editions were printed from movable types. In 1869 a stereotyped edition was printed, with some changes in the contents of the work. The editions of 1852 and 1860 contained a capital table of the sines and tangents of small arcs, which was omitted in the stereotype edition; and in this latter edition a table of addition and subtraction logarithms was introduced. The omission of the table of the functions of small arcs was hardly an improvement; and, in fact, this omission caused the early editions to command a higher price than the later stereotyped one.

The present edition by Dr. Albrecht combines the excellences of both the preceding editions. It contains the table of the logarithmic sines and logarithmic tangents of arcs up to 5° for each 1″, and also includes the addition and subtraction tables.

The rest of the work is the same as the stereotype edition of 1869, except that four new pages of convenient constant logarithms are inserted, and that certain tables relating to units of weight and measure are omitted.

This collection of tables is a very practical and valuable addition to our present means of computation, and it will be welcomed as such. In the opinion of the writer, it is also the most satisfactory single collection of tables for students' use, although much can be said in favor of the best of the five-place tables for this purpose. EDWARD S. HOLDEN.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Astrophysical observations of Jupiter. — Ricco publishes a fine series of eighteen drawings of the planet, made, with one exception, in 1881, 1882, and 1883, by means of the ten-inch telescope of the observatory of Palermo. He gives, also, a large number of micrometrical measures, and detailed descriptions of the appearance of the planet and its surface-markings, on forty-seven different dates. The effect of the 'red spot' upon the contour of the adjacent belts is well brought out. — (*Mem. soc. spettr. ital.*, May, 1883.) C. A. Y. [172

Photometric observations of eclipses of Jupiter's satellites. — Cornu and Obrecht give the results of some experiments upon artificial eclipses made to imitate the eclipses of Jupiter's satellites, using the method already referred to in these columns. They find that the probable error in determining the time when the light of the satellite is reduced to one-half its normal amount is about a hundredth of the total time of obscuration. They propose, also, the use of a polariscopic arrangement in place of the 'cat's-eye,' and, in this connection, append the following note: "We have recently learned that the astronomers of Harvard college employ an analogous arrangement — of which, however, the description is not known to us — for the purpose of determining the moment of disappearance (*pour arriver à définir l'époque de l'éclat nul*). If the apparatus is analogous, the method of observation is, as one sees, entirely different." They have evidently been misinformed; for the very essence of Prof. Pickering's plan consists in the determination, not of the moment of disappearance, but of half-brightness. — (*Comptes rendus*, June 25, 1883.) C. A. Y. [173

MATHEMATICS.

Surfaces of constant curvature. — M. Weingarten here deals with certain properties of the linear elements on surfaces with a constant measure of curvature. Certain considerations connected with the modern theory of functions, particularly that portion of the theory which deals with linear differential equations of the second order, have led him to conjecture that the determination of the geodetic lines upon a surface of constant curvature, by means of certain given linear elements, stands in a close relation to the theory of the linear differential equations of the second order. M. Weingarten makes the remark (which, though not new, is important here) that the extension of those properties of curved surfaces, studied and enunciated by Gauss, which depend upon a given form of the linear element, is much simplified by the introduction of certain functions of the position of a point upon the surface. The values of these functions are given in terms of the coefficients of the linear element in such a way, that, by the introduction of new (two) variables, we arrive again at the original linear element. The functions possessing this (invariantive) property are called flexion-invariants (*biegungsinvarianten*). As an example of flexion-invariants, we have the 'measure of curvature' of a surface. From the differential coefficients of a flexion-invariant, and the Gaussian coefficients, E, F, G, of a linear element of a surface, an indefinite number of new invariants can be formed, two only of which are independent. The author gives a brief account of Beltrami's work on these functions, and then considers particularly the surfaces of constant curvature. The paper is an exceedingly interesting one to the student of this particular branch of geometry, and is a valuable addition to the previous memoirs, by M. Weingarten, on this and cognate subjects. — (*Journ. reine ang. math.*, 1883.) T. C. [174

PHYSICS.

Density of the earth — Major R. v. Sterneck of the government Military-geographical institute of Vienna, last year, tried Airy's method of the determination of the earth's mean density in the St. Adalbert shaft of the silver-mines at Příbram, Bohemia, at depths of 516 and 972.5 metres. His average result was 5.65, which agrees closely with the values determined by other methods. On comparing his measures with Airy's, a curious agreement appears in the number of seconds gained by a clock at different depths, and a continual decrease in the deduced mean density as the depth increases. Airy found (1854), at a depth of 383 metres, that his clock gained $2^s.25$ a day, and the density was 6.57; v. Sterneck's figures are 516, $2^s.4$, and 6.28, and 972, $2^s.3$, 5.01, respectively: whence he concludes, "that, in the interior of the earth, the resultant of gravity, centrifugal force, and the attraction of the superincumbent mass, is constant." — (*Mitth. k.-k. milit.-geogr. inst. Wien*, 1882, ii. 77.) W. M. D. [175

Electricity.

Geographical variation of horizontal intensity. — F. Kohlrausch proposes to use a form of his local-variometer (described in *Ann. phys. chem.*, xviii. 545) in which the scale is at a distance A from the axis of suspension, and attached to the instrument, and obtains between the horizontal intensities at two different places the relation —

$$\frac{H' - H}{H} = \frac{\tan \phi}{4A}(n' - n) + \mu(t - t');$$

ϕ being the angle through which the frame of the instrument is turned, n and n' the deflections in scale-divisions, and μ a coefficient of the temperature, t. — (*Ann. phys. chem.*, xix. 130.) J. T. [176

Thermochemical properties of electromotive force. — Edlund investigates the thermal changes at the electrodes of a voltameter by placing the junctions of a thermopile in front of the electrodes, and enclosing both in a porous membrane. He finds, that, when the electrodes are copper and the liquid copper sulphate, the electromotive force between the metal and the liquid uses less heat for formation of current than is set free in the formation of copper sulphate.

The same law holds for zinc and zinc sulphate, cadmium with its acetate, and lead with its acetate; but for silver, with its sulphate, nitrate, and acetate, the law is reversed. In a Daniell cell, *a fortiori*, less heat is used for formation of current than is set free in the chemical action of the cell. — (*Ann. phys. chem.*, xix. 287.) J. T. [177

CHEMISTRY.

(*General, physical, and inorganic.*)

Speed of dissociation of brass. — Mr. E. Twitchell (under Prof. Robert B. Warder's direction) made the following determinations, which were suggested by Bobierre's method for the separation of copper and zinc in alloys. A piece of brass wire (no. 17) 150 mm. long and 1.43 mm. in diameter was heated to redness in a stream of hydrogen in a porcelain tube. The loss in weight, from hour to hour, is given in the following table: —

Time in hours.	Weight of alloy.	Loss per hour.	Zinc present.	A.
0	2.0570		.7409	
1	1.9128	.1442	.5967	92
2	1.8527	.0601	.5366	70
3	1.7855	.0672	.4694	66
4	1.7418	.0437	.4257	60
5	1.7168	.0250	.4007	53
6	1.6957	.0211	.3796	48
9	1.6624	.0111	.3463	37
12	1.6339	.0095	.3178	31

The figures given under A are proportional to the 'coefficient of speed,' as calculated from each observation, on the hypothesis that the zinc expelled at each moment is proportional to the whole quantity of zinc present. The steady decrease in the last column shows that this hypothesis does not obtain under the conditions of the experiment, but that an appreciable interval of time is required for the transfer of zinc from the central portion to the surface of the wire. Further experiments upon this *diffusion* of zinc are in progress. — (*Sect. chem. phys. Ohio mech. inst.; meeting* May 31.) [178

AGRICULTURE.

Influence of temperature and rainfall on the wheat-crop. — A comparison of the average temperature and the rainfall in England during the months of July and August for the last thirty-six years, with the corresponding wheat-crop, justifies the following conclusions: provided the stand of the crop at the beginning of July is promising, a temperature above the average for the succeeding two months insures more than an average crop as regards quantity, unless extraordinary circumstances, such as violent storms, intervene. Rainy weather may reduce the quality of the crop. On the other hand, however promising the crop may be at the end of June, a temperature below the average in July and August involves a small crop. If the weather is clear, the quality may be good, while, if cold and rain are united, the poorest crops are the result; such as those of 1879, when the temperature was 2.8° F. below the average, and the rainfall four inches above the average, or that of 1816 (the poorest crop on record), when the temperature was 4.8° F. below the average. — (*Bied. centr.-blatt.*, xii. 291.) H. P. A. [179

Effect of phosphatic manures in drought. — In the course of some field-experiments made during the very dry season of 1881, Emmerling observed that in one case manuring with ammonia alone produced a greater gain than manuring with ammonia and superphosphate. The result may have been accidental, as no duplicate trials seem to have been made; but Emmerling thinks that the manuring with phosphoric acid hastened the ripening of the plants, while the ammonia had the opposite effect of postponing the ripening, and keeping the plants green longer. (This effect of phosphoric acid has been observed in water-culture experiments, and silica also seems to exert a similar action.) — (*Bied. centr.-blatt.*, xii. 297.) H. P. A. [180

Damage to grain by wetting. — Märcker has examined a sample of barley which had been exposed to rain for fourteen days after it was cut. A considerable proportion of the starch had been converted into sugar. A loss of about six per cent of starch took place. The albuminoids were also altered, both the insoluble and soluble proteine having been partially converted into amides. The proportion of seed capable of germination was reduced from ninety-eight per cent to forty-five per cent. Kobus obtained similar results in an examination of damaged wheat. — (*Bied. centr.-blatt.*, xii. 326.) H. P. A. [181

MINERALOGY.

Enclosures in muscovite. — The occurrence of biotite and muscovite in one crystal is well known, and has been investigated by H. Carvill Lewis. He prepared cleavage-sections from one specimen, and arranged them in the order in which they occurred. The biotite contrasts strongly with the light-colored muscovite, and has often well-defined edges. The two micas are arranged symmetrically in relation to their prismatic planes, as may be shown by the crystal edges when they are well developed, or by the strike-figures which are parallel in the two micas in the same folia, making it probable that they have crystallized together out of the same solution. In examining a series of sections from one specimen, it is found that the proportion of the two micas varies in different parts of the crystal; the biotite, the more unstable of the two species, gradually giving way, and being changed into the more hardy muscovite.

Of a different nature are the superficial markings of magnetite, which occur from various localities. These markings form a series of branching lines, which run in three directions across the plates of the mica, crossing each other at angles of 60°, and have been regarded as repeated twinning around a dodecahedral axis. These lines, however, as shown by the author, bear a fixed relation to the axes of the mica, and are not due to any inherent property of the magnetite. If a crystal showing these markings be dissected, the lines of marking will all be found to lie in parallel direction; nor is there any direct connection with the markings on adjacent plates: one may be covered by the markings, the next free from them. The magnetite does not penetrate, but lies superficially upon the mica plates, and the lines follow the direction of the rays of the strike-figure. The author regards the magnetite as not derived from any external source, but from the muscovite itself, occurring, not along cracks or near the exterior of the crystals, but grouped in the interior of the same. — (*Proc. acad. nat. sc. Philad.*, Dec., 1882.) S. L. P. [182

GEOGRAPHY.

(Europe.)

Deformation of the earth's surface. — J. Girard calls attention to some interesting observations on apparent changes of level of neighboring points. One account attested by Girardet (*Exploration*, June, 1882) is of villages in the Jura which were hidden from each other at the beginning of the century, or even only forty years ago, but are now in sight. First the roofs, and later the walls, became visible by the slow warping of the ground. Another example is recorded in Bohemia, about thirty miles south of Karlsbad, where the people of Hohen Zedlisch are convinced that their village is rising; for thirty years ago they could see only the top of the church-spire in Ottenreuth, while now more than half of it is in view, and some roofs of lower buildings have also risen into sight. A line of levels has been run here to detect any further changes (*Congres sc. géogr.*, 1875). Girard does not attempt any criticism of these statements, but accepts them as proved. There would seem to be room for other explanations than the one suggested. — (*Rev. de géogr.*, 1883, 349.) W. M. D. [183

Maps of Norway. — The Norwegian geographical survey (Geografiske opmaaling) has published maps as follows: a guide-map, showing the progress of triangulation from 1779 to 1876 (only a small part of this work remains unfinished), — based upon this are several topographic maps on various scales: for the southern part of the country some are even 1 : 50,000 (or 1 : 10,000), in many sheets; the general map of southern Norway (1 : 400,000), in eighteen sheets; district-maps (1 : 200,000); and rectangle-maps (1 : 100,000), in fifty-four sections, with contours and mountain shading, and the larger bodies of water in blue. This serves as a basis for the geological survey under Prof. Th. Kjerulf. A general geological map (1 : 1,000,000) is also published. The coast-survey publishes charts of the southern shores on 1 : 50,000; of the northern, on 1 : 100,000. Thirty-two of the former and thirteen of the latter are completed. Besides these, there are a general coast-map (1 : 200,000) in thirteen sheets, and another on a smaller scale in five sheets, and fishery-maps (1 : 100,000) in eleven sheets. — (*Mitth. geogr. ges. Wien*, xxvi. 1883, 190.) W. M. D. [184

The Bavarian forest. — The physical features of this submountainous district, extending north of the Danube below Regensburg, are described under its topography and geology by Dr. C. W. von Gümbel, and its climatic relations by Dr. Ebermayer. The article is hardly susceptible of concentration, and we reproduce only what is said concerning the glaciation of the higher ground contemporaneous with that of the Alps. It is admitted that the diluvial deposits do not point with distinctness to glacial action, that striations and moraine-walls can hardly be recognized, and that the characteristic morainic landscape, so pronounced near the adjacent Alps, is absent here; but the numerous small lakes in the higher parts of the country (Arber-, Rachel-, Bestritzer-, Girgl-See and others), and the plentiful peat-swamps, the remains of extinct water-basins, are accepted as evidence of former glaciation. Among all the lakes, there is not one which cannot be explained as resulting either from local glacial erosion, or from obstruction of old valleys by drift-deposits. — (*Deutsche geogr. blätter*, vi. 1883, 21.) W. M. D. [185

(Asia.)

Telegraph-line in China. — Since the destruction of the short railroad from Shanghai to Wusung by the Chinese shortly after its building in 1877, it has been thought that there would be opposition to further introduction of foreign contrivances; and two years ago, when the construction of a telegraph-line was begun between Shanghai and Tientsin, a party of soldiers was detailed to guard the foreign engineers employed on it. The caution proved unnecessary; and the chief difficulties encountered were the numerous canals, some of which had to be crossed by cables. The want of good roads was a serious embarrassment when the line ran at a distance from the grand canal. The line is 938 miles in length, and required nearly twenty thousand poles. The construction was begun in June, 1881, at the two termini, and in December was opened to public use. — (*Pet. geogr. mitth.*, 1883, 231.) W. M. D. [186

Explorations in Cambodia. — Dr. Néis announces his arrival in Laos, on the border of Siam. From Sambok to Sombor the Mekong River is a continuous series of rapids, passable only for the native canoes. Thence above to Laos the left bank is encumbered with shoals. The country is chiefly covered with forests, which, along the river, are infested by Chinese pirates, who render river-traffic between Laos and Cambodia very limited. Laos contains some two hundred houses, and two thousand inhabitants, — Laotians and Chinese, who raise cotton and rice. The commerce is small, iron money is in use, and the Chinese are the chief traders. The ruins described by Garnier, to examine which was the chief object of the expedition, were visited. No inscriptions were found, and but a few interesting carvings. A sort of oven was filled with thousands of pieces of bark stamped, like medals, with three figures of Buddha: some retained traces of color and gilding. Some statuettes of Buddha of *faïence* were found in a vessel embedded in the cement of the oven. Dr. Néis found the fauna of Laos essentially the same as that of Cambodia. He intended, at the date of writing, to penetrate as far as Bassak, in Siam, where he would endeavor to obtain as complete collections as possible. — (*Comptes rendus soc. géogr.*, no. 11.) W. H. D. [187

BOTANY.

Influence of diminished atmospheric pressure on the growth of plants. — Experiments conducted by Wieler at Tübingen show, that, all other external conditions being the same, plants will grow more rapidly under *diminished* atmospheric pressure. Thus, if a specimen of the common Windsor bean (Vicia faba) be grown in a receptacle in which the pressure of the air can be controlled, it will be found to grow faster until the pressure has been diminished to 100–300 mm.; the normal pressure under which the ancestors of the plant have flourished being, of course, not far from 760 mm. If, however, the pressure is reduced below the smaller figure given above, the rate of growth diminishes. Wieler found that the curve of growth of the sunflower is about the same as that of the bean. It was further shown by his experiments, that growth is retarded by increased pressure until the minimum is reached at 2–2½ atmospheres, from which point there is again an increase. Although the short abstract of these interesting results so far published is meagre in the extreme, it indicates that the field entered upon by Wieler (and by Bert in France) may compel us to revise some notions now held in regard to the adaptation of plants to their surroundings in past ages, and at the present time upon high mountains. — (*Botan. zeit.*, July 6.) G. L. G. [188

Pollination of Cypella. — Two Brazilian species of this genus of Irideae have been studied from time to time by Fritz Müller, who finds a number of interesting peculiarities in their flowering. The flowers, like those of Cordia, etc., are produced in abundance only on certain days, which recur more or less regularly, and apparently independently of climatic conditions. Nectar is secreted in pockets on the three petals, which are flexible, so that when a Xylocopa or Bombus, to which the flowers seem well adapted, alights on one in quest of nectar, it bends over with the weight of the bee, whose back is brought in contact with a stigma and the underlying anther. Commonly the bee goes immediately to another flower without trying the other petals of the one on which it has first settled, so that crossing is effected by it. One of the species studied proves to have self-impotent pollen: the other is fertile with its own pollen. The stingless bees (Trigona), though not necessarily excluded by structural peculiarities from the nectar, do not obtain it readily; yet their visits for the protectively colored (pale-bluish) pollen are sufficiently numerous to prevent the larger bees from visiting the flowers in numbers. — (*Berichte deutsch. bot. gesellsch.*, April 3, 1883.) W. T. [189

ZOÖLOGY.

(General physiology and embryology.)

Influence of gravity on cell-division. — E. Pflüger, by placing fresh laid frogs' eggs in a watch-glass, and adding a little water with semen, and pouring it off in a few seconds, was able to impregnate the eggs without allowing the gelatinous envelopes time to swell. The eggs then adhered to the glass, and so could be brought into various positions. The first division occurs in three hours, and always in a vertical plane, no matter how the axis of the egg lies. When the axis of the egg (from dark to white pole) lies horizontally, the plane of division is still always vertical, but may form any angle with the ovic axis. The influence of gravity is also shown in that the upper pole divides more rapidly than the lower. If the position of the egg is exactly reversed, this still holds true, and development progresses; so that repeatedly the medullary furrow, with its high bordering ridges (nervous system), was found upon the *white* side when this was uppermost. Out of seventeen eggs, twelve developed so that the median plane of the body of the embryo coincided with that of the first division of the yolk. (This fact of a relation between the lines of cleavage and the axes of body is not novel, as Pflüger seems to think: there are many observations on various animals which prove such a relation.) From these experiments it results that the topography of the organs is not determined by the arrangement of the substance around the axes of the egg, but that the axis around which the organs are grouped is determined by gravity. — (*Pflüger's arch. physiol.*, xxxi. 311.) C. S. M. [190

Mammals.

Germ-layers of rodents. — A. Fraser finds in the common gray rat and the house mouse the same arrangement of the layers as in the guinea-pig. The *decidua* appears to differ in the mode of its formation from that which ordinarily obtains; and the very early, rapid, and voluminous formation of its solid mass appears to have some close and constant relation to the peculiar inversion of the blastodermic layers which is found in these rodents. — (*Journ. roy. micr. soc. Lond.*, June, 1883, 345.) C. S. M. [191

Intestinal absorption of fat by lymph-cells. — Zawarykin has studied the small intestine during active digestion, making sections stained with perosmic acid and picrocarmine. The material was obtained from dogs, rabbits, and white rats. The lymph-cells are found between the epithelial cells covering the follicle and in the underlying adenoid tissue, and finally in the mouths of the chylous vessels. These cells alone contain any fat, being charged with globules of various sizes. Their multifarious irregular forms, and the inconstant shape of the nucleus, indicate that they were performing active amoeboid movements when fixed by the osmic acid. From these appearances Zawarykin concludes that the lymph-cells (leucocytes) resorb the fat: they enter the epithelium, seize the particles of fat by amoeboid movements, then descend between the cylinder-cells, through the sub-epithelial endothelium and adenoid tissue, into the roots of the chylous vessels. In Peyer's patches the cells are present in crowds, and the resorption of fat seems particularly active at those points. (The presence of lymph-cells between the epithelial cells of the intestines has been known for some time, but the significance of their occurrence has not been heretofore understood. Sewall advanced the view that the immigrant cells remain and become epithelial cells; but that appeared highly improbable. The manner in which fat is absorbed has been much discussed of late years, but the explanation given by Prof. Zawarykin appears to us the first satisfactory one which has been offered.) — (*Pflüger's arch. physiol.*, xxxi. 231.) C. S. M. [192

ANTHROPOLOGY.

Brain-weight of boys and girls. — In the final result of the comparison of the two sexes in the human race, anatomical researches will form an important factor. Many anatomists have recognized this fact, and have instituted comparisons between the sexes from various points of view. M. Gustave le Bon reviews the work of M. Manouvrier and that of M. Budin, both of whom aver that "sex has no influence on brain-weight. With them the influence of sex is nothing more than the influence of height; and if the females as a whole exceed the males in brain-weight, it is simply because the weight of the body in the females is much below that of the males." M. le Bon puts the theory of his adversaries to the test in a very ingenious manner by comparing the brains of males and females having about the same weight. By this investigation it is shown that in the great majority of cases the male children surpass the females of the same weight in their cranial circumference. At the same age, height, and weight of body, the female brain is notably smaller than that of the male. — (*Bull. soc. anthrop. Paris*, v. 524–531.) J. W. P. [193

The Galibis. — The tribe of Galibis lives on the borders of the Sinamari, and not far from Cayenne, in French Guiana, and it consists of only a few families. A group of fifteen of them were sent to Paris in 1882; and several gentlemen, among them Mr. Manouvrier, have undertaken to study their physique, customs, language, etc. The Galibis were domiciled in their native fashion in the *jardin d'acclimatation*, and passed their time in their ordinary pursuits. The skin is reddish brown, but differs with individuals, owing partly to mixed blood: the true color is also disguised by the use of paint. The hair and eyes are jet black. The other physical characters, as well as their language and occupations, are given with the greatest minuteness. A single observation will show the extreme caution with which fine theories should be spun. M. Capitan studied carefully the processes of making pottery among the Galibis. Hamy took occasion to remark upon this as upon the greater rudeness of ornamentation in other respects, and concluded that the Galibis had much degenerated since they were first studied. But Mortillet recalled the discussion to a sober view by remarking that the specimens in our museums are choice objects, selected by travellers for their great beauty, while those made by the Galibis in the jardin were by rude workmen for daily use. They show us the cabin of the poor, while the voyagers had despoiled the homes of the rich. Theories of degeneration based upon Hamy's facts were therefore unsubstantial. — (*Bull. soc. anthrop. Paris*, v. 602.) J. W. P. [194

African psychology. — Max Buchner, writing to *Ausland*, speaks rather encouragingly of the Bantu negro character. "The negro in his native condition is not apparently of a lower grade of natural intelligence than the European of the common class. He probably excels the European in a kind of selfish cunning, while the restraints of moral scruples and of the finer feelings operate less strongly upon him. Yet he is not destitute of a sort of moral instinct, a kind of taboo conscience, that causes him to hesitate to do wrong. For this reason the negro is never an open thief." Mr. Jefferson used to say that his slaves were all honest, but they could beat the world finding things. The negro, says Buchner, is above every thing positivist, practical, materialist, and is inaccessible to intangible considerations. The question 'Has the negro a religion?' cannot be answered at once, either affirmatively or negatively. It must first be made clear what is to be understood by religion. He has a confused mixture of vague wants and superstitious impulses. A system of computing time can hardly be predicated of such a people; but they have a kind of superficial calendar of the months, which they make to help regulate their agricultural operations. The negro undoubtedly possesses all the capacities for education and civilization to at least as great an extent as our primitive ancestors. The fact that the psychical and intellectual, as well as the physical, differences between particular races of men are really insignificant, is destined to be made plainer, the more the subject is impartially studied; and the efforts of certain men, learned in distinctions of types, to set up fixed marks of separation between them, will not succeed. — (*Pop. sc. monthly*, July.) J. W. P. [195

NOTES AND NEWS.

The unexampled recent increase in the membership of the American association for the advancement of science, from a little over one thousand just before the Boston meeting of 1880, to nearly two thousand now, implies a considerable increase in its funds, and should imply direct participation by the association in the endowment of research, which its means have not hitherto permitted. No other way is now open for the association to advance science so securely.

We desire, therefore, to call the attention of the executive board of the association to the direct advantage which would certainly result in following the example of the British association by making an annual grant to the Naples zoölogical station, whose claims and advantages have already been so well stated in our columns by Miss Nunn and Dr. Whitman. The board would find no lack of applicants for the table thus secured, the cost of which would be four hundred dollars annually.

— Mr. George M. West of Escanaba, Mich., sends us a photograph of a hoe-shaped implement which is stated to have been made of native copper by hammering. The blade has a thin edge, and is said to be nearly nine inches long, about three inches wide, and one-half inch thick at the back where it joins the shank. The shank is an inch square at its union with the blade, six inches long, and half an inch square at its distal end. This implement was found in Brown County, Wis., and is, we believe, unique among the many copper objects found in North America, of which Wisconsin has yielded so large a proportion. While we have no reason to doubt the statement that this implement is made of native copper, we should rather have it placed in our hands for careful examination before committing ourselves as to its character and use. Should it prove to be all that the photograph suggests, we should like to give a description, with figures.

— In the first part of an article on 'Zoölogy at the Fisheries exhibition,' *Nature* of July 26 gives unstinted praise to the collections, public and private, exhibited by the United States, and admires the beauty of the marine objects shown by the Naples zoölogical station. Speaking of the collections shown by the U. S. fish-commission, it says, "It is not an exaggeration to say that this collection, both on account of the range and variety of its objects and the instructive way in which they have been disposed and treated by the American commissioner, Mr. Brown Goode, has been the admiration of all visitors."

— According to *Nature*, the Berlin academy of sciences has granted the following amounts from its Humboldt fund: 5,000 marks ($1,250) to Dr. Otto Finch, for working at the collection he made during his journey in Polynesia; 6,000 marks ($1,500) to Dr. Ed. Arning (Breslau), for researches on the leprosy epidemic in the Hawaiian Islands; the same amount to Dr. Paul Güssfeldt, to enable him to continue and extend his exploring tour in the Andes of Chili.

— The *Société industrielle de Mulhouse* has awarded its silver medal (*médaille d'argent hors concours*) to Mr. C. J. H. Woodbury of the Boston manufacturers' mutual fire-insurance company for his book, 'Fire protection of mills.'

— Dr. J. W. Mallet has resigned the professorship of chemistry in the University of Virginia.

RECENT BOOKS AND PAMPHLETS.

**** Continuations and brief papers extracted from serial literature without repagination are not included in this list. Exceptions are made for annual reports of American institutions, newly established periodicals, and memoirs of considerable extent.*

Adams, C. Francis, jun. A college fetich: address before the Harvard chapter of the fraternity of the Phi Beta Kappa in Sander's theatre, Cambridge, June 28, 1883. Boston, *Lee & Shepard*, 1883. 38 p. 8°.

Caspari, H. Beiträge zur kenntniss des hautgewebes der cacteen. Halle, *Fausch & Grosse*, 1883. 53 p. 8°.

Fletcher, R. Human proportion in art and anthropometry. A lecture delivered at the National museum, Washington, D.C. Cambridge, *King*, 1883. 37 p., illustr. 8°.

Greenwood, *Major*. Aids to zoölogy and comparative anatomy. London, *Baillière*, 1883. 120 p. 12°.

Hahn, G. Der pilz-sammler, oder anleitung zur kenntniss der wichtigsten pilze Deutschlands und der angrenzenden länder. Gera, *Kanitz*, 1883. 9+87 p., 23 col. pl. 8°.

Hale, H. The Iroquois book of rites. Philadelphia, *Brinton*, 1883. (Brinton's libr. aborig. Amer. lit., ii.) 222 p. 8°.

Hann, J. Handbuch der klimatologie. Stuttgart, *Engelhorn*, 1883. 10+764 p. 8°.

Hawkins, B. W. Comparative anatomy as applied to the purposes of the artists. Edited by George Wallis. London, *Winsor & Newton*, 1883. 90 p., illustr. 12°.

Hellmann, G. Repertorium der deutschen meteorologie. Leistungen der Deutschen in schriften, erfindungen, und beobachtungen auf dem gebiete der meteorologie und des erdmagnetismus von den ältesten zeiten bis zum schlusse des jahres 1881. Leipzig, *Engelmann*, 1883. 23+996 p., illustr. 8°.

Hofmann, J. Flora des Isargebietes von Wolfratshausen bis Deggendorf, enthaltend eine aufzählung und beschreibung der in diesem gebiete vorkommenden wildwachsenden und allgemein kultevierten gefässpflanzen. Landshut, *Krüll*, 1883. 64+377 p., 1 col. pl. 8°.

Jahn, H. Die electrolyse und ihre bedeutung für die theoretische und angewandte chemie. Wien, *Hölder*, 1883. 9+206 p. 8°.

Kalischer, S. Goethe als naturforscher und Herr du Bois-Reymond als sein kritiker. Eine antikritik. Berlin, *Hempel*, 1883. 90 p. 8°.

Kingston, W. H. G. Stories of the sagacity of animals. Cats and dogs. London, *Nelsons*, 1883. 162 p., illustr. 8°.

Leon, Néstor Ponce de. Diccionario tecnológico, Inglés-Español y Español-Inglés, de los terminos y frases usados en las ciencias aplicadas, artes industriales, bellas artes, mecánica, maquinaria, minas, metalurgia, agricultura, comercio, navegacion, manufacturas, arquitectura, ingeniería civil y militar, marina, arte militar, ferro-carriles, telégrafas, etc. pt. i., ii. N.Y., *de Leon*, 1883. 48, 49+96 p. 4°.

Mann, F. Abhandlungen aus dem gebiete der mathematik. Würzburg, *Stahel*, 1883. 5+43 p. 8°.

Maudsley, H. Body and will: being an essay concerning will in its metaphysical, physiological, and pathological aspects. London, *Paul*, 1883. 330 p. 8°.

Meyer, A. Das chlorophyllkorn in chemischer, morphologischer, und biologischer beziehung. Ein beitrag zur kenntniss des chlorophyllkornes der angiospermen und seiner metamorphosen. Leipzig, *Felix*, 1883. 7+91 p., 3 col. pl. 4°.

Miller-Hauenfels, A. von. Theoretische meteorologie. Ein versuch, die erscheinungen des luftkreises auf grundgesetze zurückzuführen. Mit einer begleitschreiben von Dr J. Hann. Wien, *Spielhagen*, 1883. 8+129 p., illustr. 8°.

Nichols, W. R. Water-supply considered mainly from a chemical and sanitary stand-point. N.Y., *Wiley*, 1883. 6+232 p., illustr. 8°.

Oborny, A. Flora von Mähren und Österreich-Schlesien, enthaltend die wildwachsenden, verwilderten und häufig angebauten gefässpflanzen. i theil: Die gefässkryptogamen, gymnospermen und monocotyledonen. Brünn, *Winiker*, 1882. 268 p. 8°.

Pfaff, F. Die entwickelung der welt auf atomistischer grundlage. Ein beitrag zur charakteristik des materialismus. Heidelberg, *Winter*, 1883. 10+241 p., illustr. 8°.

Salomon, C. Nomenclator der gefässkryptogamen oder alphabetische aufzählung der gattungen und arten der bekannten gefässkryptogamen mit ihren synonymen und ihrer geographischen verbreitung. Leipzig, *Voigt*, 1883. 10+385 p. 8°.

Schell, A. Die methoden der tachymetrie bei anwendung eines ocular-filar-schrauben-mikrometers. Wien, *Seidel*, 1883. 5+49 p., illustr. 8°.

Seebohm, F. The English village community, examined in its relations to the manorial and tribal systems, and to the common or open field system of husbandry. London, *Longmans*, 1883. 464 p., 13 maps and pl. 8°.

Sterne, C. Sommerblumen. Mit 77 abbildungen in farbendruck nach der natur gemalt von Jenny Schermaul und mit vielen holzschnitten. lief. i., ii. Leipzig, *Freytag*, 1883. 64 p. 8°.

Suess, E. Das antlitz der erde. Mit abbildungen und kartenskizzen. abth. i. Leipzig, *Freytag*, 1883. 310 p. 8°.

Thompson, Silvanus P. Dynamo-electric machinery: lectures, reprinted from the Journal of the society of arts, with an introduction by Frank L. Pope. N.Y., *Van Nostrand*, 1883. 218 p., illustr. 24°.

Villicus, F. Zur geschichte der rechenkunst mit besonderer rücksicht auf Deutschland und Oesterreich. Wien, *Pichler*, 1883. 6+100 p., illustr. 8°.

Wilson, E. The recent archaic discovery of ancient Egyptian mummies at Thebes: a lecture. London, *Paul*, 1883. 8°.

Wood, H. A season among the wild flowers. London, *Sonnenschein*, 1883. 256 p., illustr. 8°.

Zincken, C. F. Die geologischen horizonte der fossilen kohlen, oder die fundorte der geologisch bestimmten fossilen kohlen, nach deren relativem alter zusammengestellt. Leipzig, *Senf*, 1883. 7+90 p. 8°.

Zwackh-Holzhausen, W. von. Die liebenen Heidelbergs nach dem systeme und den bestimmungen Dr. W. Nylanders. Heidelberg, *Weiss*, 1883. 4+84 p. 8°.

SCIENCE.

FRIDAY, AUGUST 17, 1883.

THE AMERICAN ASSOCIATION AT MINNEAPOLIS.

The number of people who take an interest in scientific discovery is very great. We may assume that it far exceeds estimates based on the support given to scientific periodicals and societies. The question is not of thousands, but of hundreds of thousands. Of a report of Professor Tyndall's lectures on light in New York, there were sold over a half-million copies. That was ten years ago: the popular interest in science has vastly increased in the interval. This is shown by the gain of membership in the American association for the advancement of science, being within the last four years as great as in the previous thirty-one years.

Compared with what may be called the scientific following, the number of workers in science is small. Upon that following the workers must depend for recruits, and, directly or otherwise, for support. Science must lean on her friends: they are numerous, but few of them give help. There are large and rich communities where the local developments are on a par with the Pickwick club. The men and means for good work are not wanting, but the impulse is. 'Oh for the touch of a vanished hand,' like that of Louis Agassiz, to warm the dormant interest into life!

For this purpose the American association is an effective agency. It unites in one body the workers and those who are not professionally engaged in scientific pursuits. Its management should be and is favorable to the desires of both classes. In the social features of its meetings, all share alike, and perhaps with equal zest. But the workers regard the meetings chiefly as the occasions for hearing and reading 'papers.' Teachers, who form a large part of the membership, seek the most recent things of knowledge to add to their capacities for instruction. A majority of the attendants at the meetings come simply with a wholesome curiosity for the novelties of science.

The production and delivery of 'papers' at these meetings give rise to some queries. Is there any natural reason for expecting genius to burst into blossom in August rather than in any other month? If a man of science is diligently pursuing some line of research, may not the light that never was on sea or land break upon him in any other of the fifty-two weeks than the one when he can present it to the annual meeting? If he keeps back his announcement of progress or discovery, or if he brings it forward before he is fully prepared, does he not harm the cause of science and himself?

The 'papers' are of necessity often technical and uninteresting to all except experts in some special line. At one of the meetings a certain mathematician stated the case bluntly, thus: "I shall read my paper by title only, as there is nobody but myself here who can understand it." The rapidity with which a crowd of members thins out when the reading of a technical paper fairly begins, is at least suggestive. Nor should the departing crowd be denounced as simply unworthy of the pearls spread before them. They will stay if the paper has only a fair trace of popular interest. Doubtless many of those who leave the association in their first year of membership are disappointed. They had hoped for something not quite so 'dry.' Yet, if the reading of papers were dropped, the association would fail to gather the workers of science at its meetings.

Plans have at times been considered for securing addresses from men who are known as popular speakers, capable of attracting large audiences, especially if aided by suitable apparatus for the display of experiment. In various ways such a course might add largely to the resources and influence of the association. What is vastly more important, it would rouse an enthusiasm for science at the locality of the meeting, which, if rightly fostered, would give permanent results.

The association has sought to meet some of these wants and difficulties by creating a larger number of sections, each of which has a presiding officer, who is expected to deliver a formal address. This is an advance, but only a half-way measure. The papers increase in number every year; and the several sections must all work at once and arduously to finish their reading in the allotted time. To many a member, even to a specialist who may be engaged in two distinct lines of research, comes the disappointment of missing the hearing of valuable papers when two or three are delivered simultaneously.

Many of these features must appear prominently at the present meeting. The attendance will consist in greater proportion than usual of the popular element. The membership is now so large that there is no risk of the meeting being insignificant in size, as at Dubuque in 1872. But, since Minneapolis is the farthest point to the west yet tried, its distance must withhold many familiar faces. After this, we shall know better whether the kind invitations of San Francisco may be accepted two or three years hence. Next year the meeting should not be too far from the British association at Montreal.

At least eight addresses will be given by presidents of sections, — excellent in their kind, but not quite a substitute for thoughts that breathe and words that burn. If free and wide discussion could be encouraged at these meetings, the retiring president's address would now give abundant occasion. Dr. Dawson hits hard where he thinks he sees a crevice in the armor of the evolutionists or of the glacialists, and many will chafe if there is no immediate opportunity to return his thrusts. But, while it may fail of excitement, the meeting at Minneapolis is very enjoyable. The city and vicinity are picturesque and delightful. The hospitality of the west is as broad as its prairies

W. C. W.

THE IGLOO OF THE INNUIT.—I.

The Esquimaux of the arctic regions of North America call themselves 'Innuits,' and their winter-houses, built of ice and snow, 'igloos.' This short explanation may be needed to make clear my somewhat obscure title.

These strange huts have been incidentally described by many travellers in the accounts of their arctic explorations. But beyond the fact that they are rude domes of snow, in which these polar people live for the greater part of the year, little is known of the manner of their construction, their internal arrangement, or of the conditions which have led to their existence.

The many inquiries I have been called upon to answer in regard to these northern cabins, and the misconceptions I have found even among the better informed of my questioners, have led me to believe that an account of the igloo as I saw it during my life with the Innuits would be of interest.

The origin of the igloo can only be guessed from the few facts we know of early man. I will not discuss the ethnological problem which would identify the Innuit of the present day with the cave-men of Europe, but, assuming that it is true, will sketch a possible history of the ice-hut.

These cave-men are known to have existed along the edges of the *mer de glace*, which, during the ice period, overspread Europe, and buried it as Greenland is probably buried at the present day. What caused this great flow of frigidity to the south, or its retrogression to the north, it is needless to consider; suffice it to suppose that our hyperboreans followed it in all its migrations. The earliest evidences of their history are those they left in the caves of middle Europe when the glacier extended nearly to the Alps and Pyrenees, beyond which, with its outlying polar fauna of cave-men, cave-bears, cave-hyenas, mammoths, and reindeer, it never extended.

These caves were the work of nature. When these people lived in their vicinity, it is probable that they knew no other habitations, winter or summer, and disputed their possession with the many animals whose bones are found beside the implements and bones of the cave-men themselves.

As the *mer de glace*, with snail-like pace, withdrew northward, it was followed by these children of the cold (the cave-men), driven, as some suppose, by the more powerful river-drift men, or following that climate which was the more congenial.

The cave-men in their retreat, tightly held by other tribes or climatic temper, when they reached the older geologic formations which no longer gave them the welcome shelter of nature's rude houses (the dreary caves), must have looked for it from other means; and these were only stones and snow-banks. The former may have been used for their more permanent homes; but the cold interiors of stone huts in such a climate must soon have driven them to the more comfortable and easily built houses that can be excavated from a snow-bank, and so greatly resemble their old cave-homes.

During the first part of their retreat, the cave-men, cave-men no longer, were in a hilly, half-mountainous country, — a character of surface favorable to the formation of snow-drifts large enough to allow of pit or excavation, in which a family could comfortably reside. Here, then, was the first igloo, rudely cut into some protecting bank of snow, its walls knowing no other construction than that of nature. Such rough types of arctic architecture are still to be found among the mountains, where wood is unknown.

As the migrating sea of ice debouched upon the shores of the Arctic Sea, and withdrew its icy blanket from these more northern regions, the ancient arctic man found himself, as he reached those limits near the White Sea and the mouth of the Petchora, in a flatter country. The snow-drifts no longer lay in such colossal depths. They were direct functions of the surface, and flattened with it. It was no longer possible to construct a deep enough house by simple excavation. The problem was probably met by digging as far as possible, and completing the structure with banks, which in time were made of blocks of snow; for the snow of the arctic winter is not of that plastic nature which will allow one to fashion it at will, as schoolboys their forts and imitation-men, but dense and compact from the extreme cold and the packing wind. Such were the first typical and perfect igloos, a direct outgrowth of the level barren lands of the arctic zone, — features which yet determine its geographical limits.

Arctic man stopped on the shores of the sea, for in the rude means at hand he could follow the ice no farther. There was another migration to the north, which was to affect the character of his dwelling: this was the migration of the forests. As soon as wood reached his door, either by direct migration of the forests or by drifting down the great northward-trending rivers, he would naturally use it in the construction of his permanent houses, as we see to-day among the natives thus situated. The igloo was probably driven from Europe, then from Asia, and is now confined to certain localities of North America.

From writing of the igloos of the Innuits, the natural inference is, that the geographical boundaries of the two would be the same. The Innuits reach from Bering Straits (and even southward along the Alaskan coast and outlying islands) nearly to those of Belle Isle, following the sinuous coast of North America at irregular intervals. They populate the western shores of Greenland, and once occupied its eastern side. Yet this vast stretch of ocean-line must be shorn of the greater portion of its length before we can narrow it down to the part occupied by the igloo-building Innuits.

The data I have already given restricting the igloo to the barren grounds devoid of even driftwood, and the fact that nearly all Esquimaux tribes are a seacoast-abiding people, will assist us in a rough but fair approximation to its limits, — limits which can be readily made clear by reference to a map of the arctic regions of North America. The mouth of Mackenzie is about the dividing-line of the timber to the west and the barren country to the east. For considerable distances on both sides of its mouth, there is a good supply of driftwood. Where this driftwood ceases on the east is the western limit of the igloo, probably fifty to one hundred miles from the river. From this point they are found all along the coast, on the portions of the Parry Islands occupied by Esquimaux, the shores of Hudson's Bay and Straits as far as Marble Island, of Cumberland Gulf, and many of the estuaries of Baffin's Bay. The limit on the south is, I believe, Hudson's Strait, and on the east Baffin's Bay.

The time during which igloos may be built depends on the length of the winter. In summer the natives use a tent of seal or walrus skin.

The pole of greatest cold is placed by Bent to the north of the Parry Islands, nearly upon the eightieth parallel, and in about 100° W. longitude. I believe the thermometric observations made in the arctic regions, straggling as they have been, go far towards' showing that the magnetic and thermal poles are the same. This would bring the lowest temperatures six hundred miles to the south of the position assigned by Bent. Wherever it may be, there would the igloo have the longest existence for the year.

In the winter of 1878, being near Depot Island in North Hudson's Bay, we moved into igloos on the 1st of November. On King William's Land, next spring, we abandoned snow-houses, and took to tents on the 17th of June, having lived an igloo-life for seven months and seventeen days. That winter upon King William's Land we reared our first igloo on the 25th of September, being one month and five days earlier than at Depot Island the previous season. This would give a total of igloo-life for the southern part of King William's Land of eight months and twenty-two days, or nearly three-fourths of the year. This is the nearest to the pole of greatest cold (be it the magnetic pole or according to Bent) that any white men have lived *à la Innuit*. Assuming these two physical poles to be identical, and our position having been so near them, — being really only about a hundred miles distant, — we must have experienced about the maximum of annual igloo-life. Returning to North Hudson's Bay in the spring of 1880, we, as well as the majority of the Esquimaux living around Depot Island, moved into tents about the middle of May, giving igloo-life for North Hudson's Bay something over half the year, which is probably near the minimum.

While, of course, climatic causes principally determine the annual longevity of the snow-house, they are not the only ones. As soon as the spring thaws commence tumbling in the igloos, or making their structure insecure, the native would gladly avail himself of a tent; but this he cannot do, unless there be a clear spot somewhere near, on which it can be pitched. It may be a number of days from the time he would accept tent-life before the hilltops or ridges commence peeping through their winter covering. The inland ridges, higher and more marked, covered with black moss, which, once through the crust, makes sad havoc with the snow, appear much sooner than those facing the sea, which are flatter, enabling the inland reindeer hunters to occupy their tents earlier than the seal or walrus hunters of the coast. Some igloo-builders will wait until they can kill enough seal to make a new tent before using one. The Ooqueesik Salik Esquimaux of the Dangerous Rapids of the Great Fish River can be said to be practically without tents, securing nothing, or almost nothing, from which to make them. They hold to the shelter of an igloo late in the spring, and seek it as soon as one can be made in the early winter.

(*To be continued.*)

ON THE DEVELOPMENT OF THE PITUITARY BODY IN PETROMYZON, AND THE SIGNIFICANCE OF THAT ORGAN IN OTHER TYPES.

In the *Quarterly journal of microscopical science* (xxi. 750) I published a brief preliminary account of the development of the pituitary body in the lamprey, stating that it was formed from a part of the nasal sac. This account of a method of formation so entirely different from any thing that was known among the vertebrates was received with incredulity by Balfour, who says (Comp. embryology, ii. 358), "I have not myself completely followed its development in Petromyzon, but I have observed a slight diverticulum of the stomodaeum which I believe gives origin to it. Fuller details are in any case required before we can admit so great a divergence from the normal development as is indicated by Scott's statements." These fuller details have long been nearly ready for publication, but I have been prevented by circumstances from issuing them. I hope shortly to continue my series of studies on the embryology of Petromyzon, but, in the mean time, think it advisable to present this preliminary account.

My friend, Dr. Dohrn of Naples, has lately investigated this subject, and has come to the conclusion that neither Balfour nor myself can be correct, but that the pituitary body arises from an independent invagination of the epiblast between the nasal epithelium and the mouth (*Mitth. zool. stat. Neapel*, iv. 1 heft). On examining Dohrn's figures, however, I was much pleased to find that his disagreement with me is rather about terms than facts; for these drawings correspond almost exactly with those that I have already published, and many more as yet unpublished.

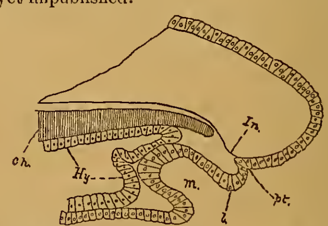


Fig. 1. — Sagittal section through head of lamprey embryo. *m*, mouth; *pt*, pituitary invagination; *In*, infundibulum; *Hy*, hypoblast of throat; *ch*, notochord; *l*, upper lip.

The development of the pituitary body, as far as I have been able to trace it, is as follows. Shortly before hatching, the mouth is formed by a deep invagination of the epiblast (see fig. 1, taken from my article in the *Morphol. jahrb.*, vii). The upper lip is somewhat rounded in longitudinal section, and bounded anteriorly by a very slight depression, which is the beginning of the pituitary body; but, as this is also the beginning of the invagination to form the nasal sac,[1] I have preferred not to separate them, as Dohrn has done. In the next stage (fig. 2)

Fig. 2. — Section through head of an older embryo just before hatching. *Olf*, olfactory epithelium. Other letters as in fig. 1.

the nasal epithelium has become much thickened, the pituitary involution deeper, and the upper lip elongated so as to become triangular in section. At this time the cranial flexure has reached its maximum; though it is far less than in most other groups, owing to the relatively small size of the fore and mid brains. The mouth is ventral in position, corresponding very closely to the selachian mouth in position and shape.

Shortly after this, the upper lip begins that remarkable series of transformations to which, as I long ago pointed out, many of the most striking peculiarities of the cyclostome organization are due. The posterior edge of the lip elongates rapidly, becoming triangular in section; while the whole anterior part of the head rotates forwards, thus tending to correct the cranial flexure, and bringing the mouth to point somewhat forward as well as downward. By this process the edge of the lip, which in fig. 2 is directed backwards, now comes to point downwards (fig. 3); at the same time, the opening of the nasal pit points forwards instead of downwards. The involution for the nasal passage and pituitary body has now become a long tube of cells, which transverse sections show us to be

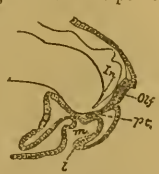


Fig. 3. — Section through head of a very young larva of the lamprey. Letters as before.

[1] By nasal sac, I mean the blind passage, as distinguished from the olfactory epithelium.

perforated by a small lumen. The end of this cellular tube reaches to the infundibulum, with which it lies in close contact. This portion will give rise to the pituitary body. Up to this time there has been no line of separation between the pituitary involution and the nasal epithelium; but when the process of rotation of the upper lip, and correction of the cranial flexure, is completed, the edge of the lip points directly forward, having passed through an angle of 180°, and the opening of the nasal sac is on the dorsal instead of the ventral surface of the head. At this time a fold appears below the olfactory epithelium, separating it distinctly from the pituitary passage.

The pituitary body is formed from part of the epithelium of this passage, and consists of solid follicles, separated by connective tissue. According to Dohrn (loc. cit., p. 178), this body is not constricted off from the passage or nasal sac at any time during larval life. I have not been able to satisfy myself, as yet, upon this point; but I am not inclined to agree with this view.

As to the morphological significance of the pituitary body, many views have been propounded, some of them bearing upon the question of the origin of the vertebrates. Some writers have contended that the conario-hypophysial tract through the brain is the remnant of the old mouth and gullet, which, in the ancestors of the vertebrates, passed through a ring of nervous tissue, as in the annelids. Space will not permit a discussion of this hypothesis; nor is such discussion necessary, as Balfour (Elasmobranch fishes, p. 170) has stated the insuperable objections to the view. Dohrn, in the pamphlet already quoted, adopts a view somewhat like one originally propounded by Götte, and adds a suggestion of his own. He considers the entire blind nasal sac of the lamprey to belong to the pituitary body, and that this sac has arisen from the coalescence of a pair of gill-slits. This hypothesis is but the carrying-out of the theory so ably advocated in the very suggestive pamphlet 'Ueber den ursprung der wirbelthiere.' But, until it can be shown that the vertebrate mouth is a new formation, the existence of pre-oral gill-clefts hardly merits discussion. I reserve for a later paper the consideration of the origin of the vertebrate mouth, — a question which is the turning-point of the solution of all these problems.

Balfour has suggested an explanation of the pituitary body. "It is," he says (p. 359), "clearly a rudimentary organ in existing craniate vertebrates; and its development indicates, that when functional it was probably a sense-organ opening into the mouth, or else a glandular organ opening into the mouth." It seems to me that the facts of its development in Petromyzon negative this hypothesis. It is there seen to have no connection with the mouth; nor is this mode of development so entirely exceptional as it would at first seem. Of all known embryos of craniate vertebrates, the lamprey has perhaps the smallest brain and the least cranial flexure; which state of things allows space for a distinct invagination from without to reach the infundibulum. In the Amphibia this is seen to a less degree: the invagination for the pituitary body is formed before the appearance of the

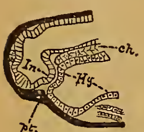


Fig. 4. — Section thro' head of embryo of Bombinator (after Götte). Letters as before.

Fig. 5. — Section through head of young tadpole of Bombinator (after Götte). Letters as before.

mouth, and just above it; so that, when the mouth appears, the two have an apparent connection, being crowded together by the increased cranial flexure. In other types — such as the selachian, bird, mammal, etc. — the brain acquires a very great size in early embryonic stages, and the cranial flexure is consequently very much increased. In these cases almost the only possible way for an epiblastic invagination to reach the infundibulum is from the epiblast of the mouth. If the reader will compare the figures given above for the lamprey with those from Götte (figs. 4 and 5) for the amphibian and that from Balfour for the selachian (fig. 6), these progressive changes will at once be clear. If embryological evidence counts for any thing, it would therefore seem extremely probable that the connection of the pituitary body with the mouth is only a secondary one, brought about by the greatly increased cranial flexure in the higher types. Assuming that the invagination originally took place independently of the mouth, such a secondary connection would be almost a mechanical necessity of the great brain-growth.

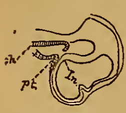


Fig. 6. — Section thro' head of embryo of Pristiurus (after Balfour). Letters as before.

Now, while I am not prepared to follow Dohrn in maintaining that the entire blind nasal sac below the olfactory capsule of Petromyzon really belongs to the pituitary body, yet I quite agree with him that the connection of the pituitary body with the olfactory organ is a secondary one. I have, in a former paper, stated the reasons for believing that the unpaired condition of the olfactory organ in the Cyclostomata is not primitive, but secondary, caused by the coalescence of two originally distinct pits. Now, if there were an independent invagination in the median line of the head, the causes which brought about the union of the two nasal sacs would also cause the latter to coincide with the pituitary involution. This is just what I conceive to have happened.

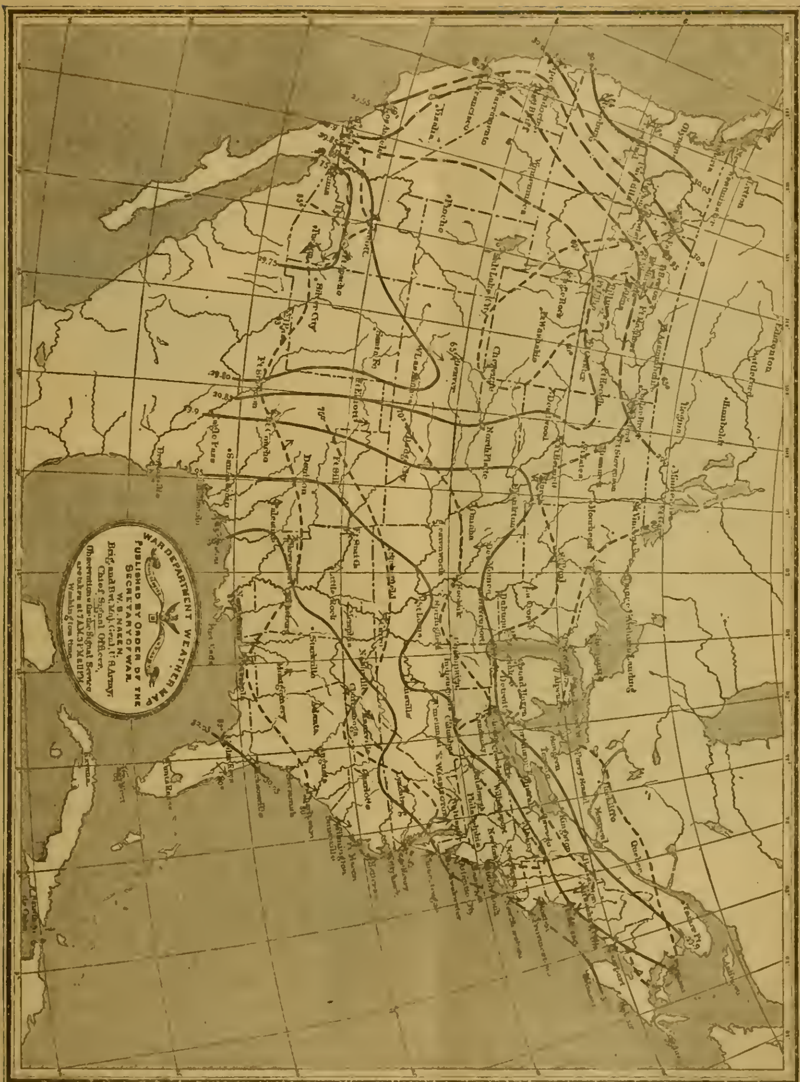
If the above reasoning be correct, the fact would seem clear, that the pituitary body is the remnant of some originally independent organ, which opened, not into the mouth, but on the surface of the head. Almost certainly this organ belonged to the invertebrate ancestor of the vertebrates. What its function was, is a difficult problem. Dohrn's hypothesis that it was formed by the coalescence of a pair of gill-clifts is untenable, not only for the reasons already given, but on account of the invariable epiblastic origin of this organ, while gill-clefts always arise in the vertebrates as outgrowths of the hypoblast. Perhaps we may modify Balfour's suggestion, and assume tentatively that it was a sense organ or gland which, having lost its function, has become rudimentary. At all events, it will be a step gained if we can establish the fact that the pituitary body is an organ originally independent both of the mouth and of the olfactory apparatus. W. B. Scott.

Morphological laboratory, Princeton, N.J., July 5, 1883.

THE WEATHER IN JUNE, 1883.

The monthly weather review of the U. S. signal-service contains in usual detail reports from all portions of the country of the weather conditions which characterized the month of June. There were no unusual meteorological features; the month exhibiting the 'average weather,' as far as this term can be realized. The destructive floods in the lower Missouri River, and in the Mississippi River between St. Louis and Cairo, the unusual rainfall in that section, and severe local storms in many of the states, are the special events of note.

The mean distribution of barometric pressure is illustrated by the accompanying chart, which also contains the mean isothermal lines,



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, JUNE, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF CHIEF SIGNAL-OFFICER.

and arrows indicating the prevailing wind-directions. The pressure conditions are quite normal, the regions of highest mean pressure being the South Atlantic and Gulf states, and the North Pacific coast. Eight areas of low pressure have been traced over the United States, with an average velocity of 24.2 miles per hour. The discontinuance of telegraphic reports from stations west of the Rocky Mountains prevented the charting of the early portions of some of the storm-tracks. The passage of the low areas was accompanied by wide-extended and in many cases severe local storms, though they were not so numerous nor so violent as those which occurred in the month of May.

The departures from the normal temperatures were in no section large. On the Atlantic coast and west of the Rocky Mountains the temperature was slightly higher than the average, and over the interior districts slightly lower. Frosts occurred in many states in the first days of the month.

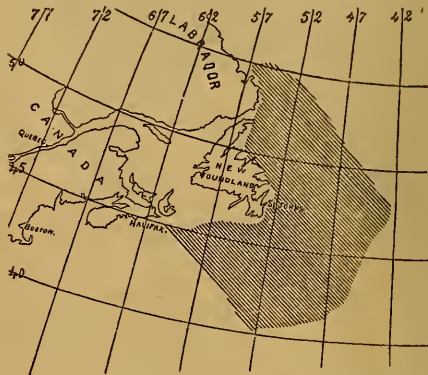
The following table contains the rainfall statistics for the month: —

Average precipitation for June, 1883.

Districts.	Average for June. Signal-service observations. For several years.	Average for June. Signal-service observations. For 1883.	Comparison of June, 1883, with the average for several years.
	Inches.	Inches.	Inches.
New England	3.60	3.36	0.24 deficiency.
Middle Atlantic states .	3.52	5.22	1.70 excess.
South Atlantic states . .	4.57	6.49	1.92 excess.
Florida peninsula . . .	5.70	4.80	0.90 deficiency.
East Gulf	4.29	4.91	0.62 excess.
West Gulf	3.37	3.73	0.36 excess.
Tennessee	4.34	3.49	0.85 deficiency.
Ohio valley	4.64	4.21	0.43 deficiency.
Lower lakes	3.26	4.04	0.78 excess.
Upper lakes	4.47	5.38	0.91 excess.
Extreme north-west . .	4.10	2.50	1.60 deficiency.
Upper Mississippi valley,	5.82	5.98	0.16 excess.
Missouri valley	6.06	7.98	2.92 excess.
Northern slope	2 53	3.43	0.90 excess.
Middle slope	2 01	2.27	0.26 excess.
Southern slope	3 26	1.70	1.56 deficiency.
Southern plateau . . .	0.40	0.03	0.37 deficiency.
North Pacific coast. . .	1.50	0.04	1.46 deficiency.
Middle Pacific coast . .	0.18	0.00	0 18 deficiency.
South Pacific coast . . .	0.02	0.04	0.02 excess.

On account of the excess of rain in the Missouri valley, disastrous floods occurred in the latter part of the month. At St. Louis the river reached the highest point since the establishment of the signal-service station. Much delay was experienced by the railways centring in St. Louis and Kansas City.

Three depressions only are charted upon the Atlantic Ocean in this month. All of these are in the eastern portion, and none are traced



ICE-CHART FOR JUNE, 1883.

from America to Europe. The weather over the North Atlantic was fair; but dense fogs prevailed from the coast of the United States eastward to the fortieth meridian. Ice was found as far east as 42° longitude, and as far south as 40°.5 latitude. During the month, icebergs drifted about three degrees eastward of the position in May. Compared with June, 1882, there is a marked decrease in the number of icebergs, and also in the amount of drifting field-ice. The accompanying chart shows the position of the ice in the month.

An interesting diagram is published in the review, showing the observations made on the steamship Assyria during her voyage from New York to Bristol, May 27 to June 11. Some of the symbols used are unexplained, however. The marked features are the rise in temperature immediately after leaving the Atlantic coast and the corresponding fall east of the fiftieth meridian, the agreement between the temperature and pressure curves, and the agreement between the temperatures of the air and sea-water.

Minor displays of auroras at various stations were reported during the month, and on the 30th an extensive but not brilliant display was noted. The number of sun-spots and groups was large. The record of halos, mirage, and meteors is large; and two water-spouts were reported, — one on Lake Erie, the other on Lake Monroe, Fla.

The verification of the tri-daily indications shows the average of 85.1 %. Of the cautionary signals displayed, 80.4 % were justified by winds exceeding twenty-five miles an hour at or within one hundred miles of the station.

THE FALL OF A BALLOON.[1]

In the August (1882) number of *l'Aeronaute*, accounts were given of the different ascents made on the 14th of July of that year. Among these ascents that of Cottin and Perron was of especial

Fig. 1.

Fig. 2.

interest, not because of the length of the voyage, but from its brevity, and on account of the fall which ended it. The balloon had barely started from Paris when a rent was formed in the upper part, and the balloon descended at Saint-Ouen. This occurrence is not entirely unknown; but that which does not

Fig. 3.

happen often is, that an artist, Mr. Jacque, chanced to be at his window, and was able to make rapid drawings of the balloon during its descent, and Mr. L. Gillon viewed the accident from the Place Wagram, and made three drawings.

Mr. Cottin, thinking that the aeronauts had not attached sufficient importance to his ascent, has published an account of it in a brochure, illustrating it with the drawings of Jacque and Gillon. He begins his statement, "It was sixteen minutes past four. The wind was blowing violently from the south-east. The temperature was 28° C. At starting, the voyagers felt nervous, and noticed some excitement in the movements of those who were assisting. Nevertheless, they started, saluting the crowd, who responded as only a sympathetic Parisian crowd knows how. They rose over the building which forms the corner of the Place Wagram. Thirty kilograms of ballast was thrown out; and, relieved of this weight, the balloon shot up. With one bound it was four hundred metres; another, and it had reached a height of six hundred metres. At this time it was just twenty-four minutes past four. The aeronauts felt that the balloon seemed to stop. They were told afterwards that they began to turn. Cottin felt a trembling of the basket. Some seconds passed. Then the noise of the flapping silk was heard."

Fig. 4.

[1] Taken, with the illustrations, from *l'Aeronaute*, June, 1883.

The balloon was torn when at a height of seven hundred and three metres, as shown by a pocket barometer which Cottin had with him, and saved in good condition. For the first hundred and twenty metres of the fall the motion was regular. Then a swinging motion began, and finally the fall

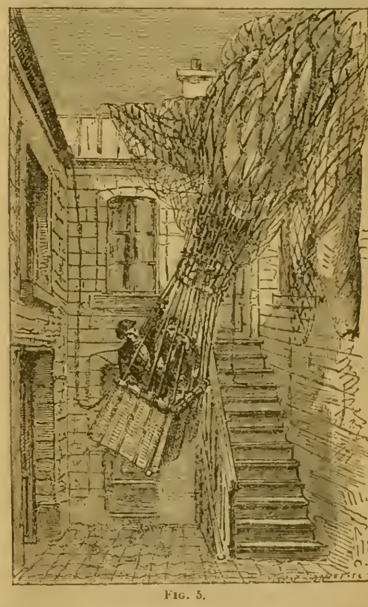


Fig. 5.

increased in speed. The oscillations increased enormously, and the basket swung through the air with a dizzying velocity. At times the balloon took up an almost horizontal position in the direction of the wind. This swinging continued till a point within a hundred and twenty or a hundred and thirty metres of the earth was reached. From this point the fall was nearly vertical, as the silk had formed itself into a parachute. During this period Mr. Perron threw out the last of the ballast, the guide-rope, and cut the cords of the anchor. Led by Perron's example, Cottin threw over a bottle of cold coffee, which, he remarks, 'might have injured or even disfigured them.'

Suddenly, without any shock, the basket seemed to drop from under their feet. A moment later they were violently thrown down by the sudden stopping of their fall. It was twenty-seven minutes past four. The ascension had lasted eleven minutes, and two minutes were occupied by the fall of seven hundred and three metres.

They found themselves suspended about two metres from the pavement in the courtyard of a house

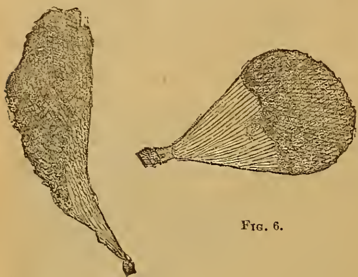


FIG. 6.

in Saint-Ouen, the ropes and material of the balloon having caught on the roof. The yard was not more than four metres long by three wide. To complete their good luck, there was a flight of steps which gave them an easy means of reaching the ground.

Mr. Jacque was in his studio, and saw the balloon in the air. Seeing that something unusual was happening, he seized a pencil, and hastily drew the successive forms which are reproduced in figs. 1 to 4. As to the drawings, he says, "I could only indicate very imperfectly the ropes and basket, which I could hardly see. It is necessary to remark, that the phases represented ought to be supposed as following closely one another, and constantly changing. I suppose that the time during which the fall was visible to me was about one minute, and the distance fallen five hundred metres. At the moment when I saw the balloon taking the last form (fig. 4), it was descending more rapidly, and disappeared behind the left slope of Montmartre. It did not seem more than one kilometre distant from me; but in this I was mistaken."

The sketches (fig. 6) of the fall as seen by M. L. Gillon are not accompanied by any explanation.

The figures are of interest as showing the form which a balloon takes when forming itself into a parachute, and give some indication of the resistance offered by the air. The parachute was doubtless of an imperfect form, and offered too great a resistance. It had, moreover, the fault of not having a central opening, on which account the air could only escape laterally, and gave rise to the fearful oscillations. In an actual parachute the central hole, of large size, allows easy escape to the air, and the oscillations are slight. It can almost be said that the resistance of a parachute increases with the size of the opening.

The balloon tore on its upper side on account of the disproportion in the ropes. The lower part, reversing, formed a closed parachute. It is not singular that the balloon should have taken such strange shapes while falling.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ADDRESS OF THE RETIRING PRESIDENT, DR. J. W. DAWSON, AT MINNEAPOLIS, AUG. 15, 1883.

SOME UNSOLVED PROBLEMS IN GEOLOGY.

MY predecessor in office remarked, in the opening of his address, that two courses are open to the retiring president of this association in preparing the annual presidential discourse, — he may either take up some topic relating to his own specialty, or he may deal with various or general matters relating to science and its progress. A geologist, however, is not necessarily tied up to one or the other alternative. His subject covers the whole history of the earth in time. At the beginning it allies itself with astronomy and physics and celestial chemistry. At the end it runs into human history, and is mixed up with archeology and anthropology. Throughout its whole course it has to deal with questions of meteorology, geography, and biology. In short, there is no department of physical or biological science with which geology is not allied, or at least on which the geologist may not presume to trespass. When, therefore, I announce as my subject on the present occasion some of the unsolved problems of this universal science, you need not be surprised if I should be somewhat discursive.

Perhaps I shall begin at the utmost limits of my subject by remarking that in matters of natural and physical science we are met at the outset with the scarcely solved question as to our own place in the nature which we study, and the bearing of this on the difficulties we encounter. The organism of man is decidedly a part of nature. We place ourselves, in this aspect, in the sub-kingdom vertebrata, and class mammalia, and recognize the fact that man is the terminal link in a chain of being, extending throughout geological time. But the organism is not all of man; and, when we regard man as a scientific animal, we raise a new question. If the human mind is a part of nature, then it is subject to natural law; and nature includes mind as well as matter. On the other hand, without being absolute idealists, we may hold that mind is more potent than matter, and nearer to the real essence of things. Our science is in any case necessarily dualistic, being the product of the reaction of mind on nature, and must be largely subjective and anthropomorphic. Hence, no doubt, arise much of the controversy of science, and much of the unsolved difficulty. We recognize this when we divide science into that which is experimental, or depends on apparatus, and that which is observational and classificatory, — distinctions, these, which relate not so much to the objects of science as to our methods of pursuing them. This view also opens up to us the thought that the domain of science is practically boundless: for who can set limits to the action of mind on the universe, or of the universe on mind? It follows that science must be limited on all sides by unsolved mysteries: and it will not serve any good purpose to meet these with clever guesses. If we so treat the enigmas of the sphinx nature, we shall surely be devoured. Nor, on the other hand, must we collapse into absolute despair, and resign ourselves to the confession of inevitable ignorance. It becomes us, rather, boldly to confront the unsolved questions of nature, and to wrestle with their difficulties till we master such as we can, and cheerfully leave those we cannot overcome to be grappled with by our successors.

Fortunately, as a geologist, I do not need to invite your attention to those transcendental questions which relate to the ultimate constitution of matter, the nature of the ethereal medium filling space, the absolute difference or identity of chemical elements, the cause of gravitation, the conservation and dissipation of energy, the nature of life, or the primary origin of bioplasmic matter. I may take the much more humble *rôle* of an inquirer into the unsolved or partially solved problems which meet us in considering that short and imperfect record which geology studies in the rocky layers of the earth's crust, and which leads no farther back than to the time when a solid rind had already formed on the earth and was already covered with an ocean. This record of geology covers but a small part of the history of the earth and of the system to which it belongs, nor does it enter at all into the more recondite problems involved; still it forms, I believe, some necessary preparation, at least, to the comprehension of these.

What do we know of the oldest and most primitive rocks? At this moment the question may be answered in many and discordant ways; yet the leading elements of the answer may be given very simply. The oldest rock formation known to geologists is the lower Laurentian, the fundamental gneiss, the Lewisian formation of Scotland, the Ottawa gneiss of Canada. This formation of enormous thickness corresponds to what the older geologists called the fundamental granite, — a name not to be scouted, for gneiss is only a stratified granite. Perhaps the main fact in relation to this old rock is that it is a gneiss; that is, a rock at once bedded and crystalline, and having for its dominant ingredient the mineral orthoclase, — a compound of silica, alumina, and potash, — in which are embedded, as in a paste, grains and crystals of quartz and hornblende. We know very well, from its texture and composition, that it cannot be a product of mere heat; and, being a bedded rock, we infer that it was laid down layer by layer, in the manner of aqueous deposits. On the other hand, its chemical composition is quite different from that of the muds, sands, and gravels usually deposited from water. Their special characters are caused by the fact that they have resulted from the slow decay of rocks like these gneisses, under the operation of carbonic acid and water, whereby the alkaline matter and the more soluble part of the silica have been washed away, leaving a residue mainly siliceous and aluminous. Such more modern rocks tell of dry land subjected to atmospheric decay and rainwash. If they have any direct relation to the old gneisses, they are their grandchildren, not their parents. On the contrary, the oldest gneisses show no pebbles, or sand, or limestone — nothing to indicate that there was then any land undergoing atmospheric waste, or shores with sand and gravel. For all that we know to the contrary, these old gneisses may have been deposited in a shoreless sea, holding in solution or suspension merely what it could derive from a submerged crust recently cooled from a state of fusion, still thin, and exuding here and there through its fissures heated waters and volcanic products.

It is scarcely necessary to say that I have no confidence in the supposition of unlike composition of the earth's mass on different sides, on which Dana has partly based his theory of the origin of continents. The most probable conception seems to be that of Lyell; namely, a molten mass, uniform except in so far as denser material might exist toward its centre, and a crust at first approximately even and homogeneous, and subsequently thrown into great bendings upward and downward. This question has recently been ably discussed by Mr. Crosby in the London *Geological magazine*.[1]

In short, the fundamental gneiss of the lower Laurentian may have been the first rock ever formed; and in any case it is a rock formed under conditions which have not since recurred, except locally. It constitutes the first and best example of these chemico-physical, aqueous or aqueo-igneous rocks, so characteristic of the earliest period of the earth's history. Viewed in this way, the lower Laurentian gneiss is probably the oldest kind of rock we shall ever know, — the limit to our backward progress, beyond which there remains nothing to the geologist, except physical hypotheses respecting a cooling, incandescent globe. For the chemical conditions of these primitive rocks, and what is known as to their probable origin, I must refer you to my friend Dr. Sterry Hunt, to whom we owe so much of what is known of the older crystalline rocks,[2] as well as of their literature and the questions which they raise. My purpose here is to sketch the remarkable difference which we meet as we ascend into the middle and upper Laurentian.

[1] June, 1883. [2] Hunt, Essays on chemical geology

In the next succeeding formation, the true lower Laurentian of Logan, the Grenville series of Canada, we meet with a great and significant change. It is true, we have still a predominance of gneisses which may have been formed in the same manner with those below them; but we find these now associated with great beds of limestone and dolomite, which must have been formed by the separation of calcium and magnesium carbonates from the sea-water, either by chemical precipitation or by the agency of living beings. We have also quartzite, quartzose gneisses, and even pebble beds, which inform us of sand-banks and shores. Nay, more, we have beds containing graphite which must be the residue of plants, and iron ores which tell of the deoxidation of iron oxide by organic matters. In short, here we have evidence of new factors in world-building, — of land and ocean, of atmospheric decay of rocks, of deoxidizing processes carried on by vegetable life on the land and in the waters, of limestone-building in the sea. To afford material for such rocks, the old Ottawa gneiss must have been lifted up into continents and mountain masses. Under the slow but sure action of the carbonic dioxide dissolved in rain-water, its felspar had crumbled down in the course of ages. Its potash, soda, lime, magnesia, and part of its silica, had been washed into the sea, there to enter into new combinations, and to form new deposits. The crumbling residue of fine clay and sand had been also washed down into the borders of the ocean, and had been there deposited in beds.[1] Thus the earth had entered into a new phase, which continues onward through the geological ages; and I place in your hands one key for unlocking the mystery of the world when I affirm that this great change took place, this new era was inaugurated, in the midst of the Laurentian period.

Was not this time a fit period for the first appearance of life? Should we not expect it to appear, independently of the evidence we have of the fact? I do not propose to enter here into that evidence, more especially in the case of the one well characterized Laurentian fossil, Eozoon canadense. I have already amply illustrated it elsewhere. I would merely say here, that we should bear in mind that in this later half of the lower Laurentian, or, if we so choose to style it, middle Laurentian period, we have the conditions required for life in the sea and on the land; and, since in other periods we know that life was always present when its conditions were present, it is not unreasonable to look for the first traces of life in this formation, in which we find for the first time the completion of those physical arrangements which make life, in such forms of it as exist on our planet, possible.

This is also a proper place to say something of the doctrine of what is termed 'metamorphism.' The Laurentian rocks are undoubtedly greatly changed from their original state, more especially in the matters of crystallization and the formation of desseminated minerals by the action of heat and heated water. Sandstones have thus passed into quartzites, clays into slates and schists, limestones into marbles. So far, metamorphism is not a doubtful question; but, when theories of metamorphism go so far as to suppose an actual change of one element for another, they go beyond the bounds of chemical credibility; yet such theories of metamorphism are often boldly advanced, and made the basis of important conclusions. Dr. Hunt has happily given the name 'metasomatosis' to this imaginary and impossible kind of metamorphism, which may be regarded as an extreme kind of evolution, akin to some of those forms of that theory employed with reference to life, but more easily detected and exposed. I would have it to be understood, that, in speaking of the metamorphism of the older crystalline rocks, it is not to this metasomatosis that I refer, and that I hold that rocks which have been produced out of the materials decomposed by atmospheric erosion can never, by any process of metamorphism, be restored to the precise condition of the Laurentian rocks. Thus there is in the older formations a genealogy of rocks, which, in the absence of fossils, may be used with some confidence, but which does not apply to the more modern deposits. Still, nothing in geology absolutely perishes or is altogether discontinued; and it is probable, that, down to the present day, the causes which produced the old Laurentian gneiss may still operate in limited localities. Then, however, they were general, not exceptional. It is further to be observed, that the term 'gneiss' is sometimes of wide and even loose application. Beside the typical orthoclase and hornblendic gneiss of the Laurentian, there are micaceous, quartzose, garnetiferous, and many other kinds of gneiss; and even gneissose rocks, which hold labradorite or anorthite instead of orthoclase, are sometimes, though not accurately, included in the term.

The Grenville series, or middle Laurentian, is succeeded by what Logan in Canada called the upper Laurentian, and which other geologists have called the Norite or Norian series. Here we still have our old friends the gneisses, but somewhat peculiar in type; and associated with them are great beds rich in lime-felspar, — the so-called labradorite and anorthite rocks. The precise origin of these is uncertain, but this much seems clear; namely, that they originated in circumstances in which the great limestones deposited in the lower or middle Laurentian were beginning to be employed in the manufacture, probably by aqueo-igneous agencies, of lime-felspars. This proves the Norian rocks to be much younger than the Laurentian, and that, as Logan supposed, considerable earth-movements had occurred between the two, implying lapse of time.

Next we have the Huronian of Logan, — a series much less crystalline and more fragmentary, and affording more evidence of land elevation and atmospheric and aqueous erosion, than any of the others. It has great conglomerates, some of them made up of rounded pebbles of Laurentian rocks, and others of quartz pebbles, which must have been the remains of rocks subjected to very perfect erosion. The pure

[1] Dr. Hunt has now in preparation for the press an important paper on this subject, read before the National academy of sciences.

quartz rocks tell the same tale, while limestones and slates speak also of chemical separation of the materials of older rocks. The Huronian evidently tells of movements in the previous Laurentian, and changes in its texture so great, that the former may be regarded as a comparatively modern rock, though vastly older than any part of the paleozoic series.

Still later than the Huronian is the great micaceous series called by Hunt the Mont Alban or White Mountain group, and the Taconian or lower Taconic of Emmons, which recalls in some measure the conditions of the Huronian. The precise relations of these to the later formations, and to certain doubtful deposits around Lake Superior, can scarcely be said to be settled, though it would seem that they are all older than the fossiliferous Cambrian rocks which practically constitute the base of the paleozoic. I have, I may say, satisfied myself, in regions which I have studied, of the existence and order of these rocks as successive formations, though I would not dogmatize as to the precise relations of those last mentioned, or as to the precise age of some disputed formations which may either be of the age of the older eozoic formations, or may be peculiar kinds of paleozoic rocks modified by metamorphism. Probably neither of the extreme views now agitated is absolutely correct.

After what has been said, you will perhaps not be astonished that a great geological battle rages over the old crystalline rocks. By some geologists they are almost entirely explained away, or referred to igneous action or to the alteration of ordinary sediments. Under the treatment of another school, they grow to great series of pre-Cambrian rocks, constituting vast systems of formations, distinguishable from each other, not by fossils, but by differences of mineral character. I have already indicated the manner in which I believe the dispute will ultimately be settled, and the president of the geological section will treat it more fully in his opening address.

After the solitary appearance of Eozoon in the Laurentian, and of a few uncertain forms in the Huronian and Taconian, we find ourselves in the Cambrian, in the presence of a nearly complete invertebrate fauna of protozoa, polyps, echinoderms, mollusks, and crustacea; and this not confined to one locality merely, but apparently extended simultaneously throughout the ocean. This sudden incoming of animal life, along with the subsequent introduction of successive groups of invertebrates, and finally of vertebrate animals, furnishes one of the greatest of the unsolved problems of geology, which geologists were wont to settle by the supposition of successive creations. In an address delivered at the Detroit meeting of the association in 1875, I endeavored to set forth the facts as to this succession, and the general principles involved in it, and to show the insufficiency of the theories of evolution suggested by biologists to give any substantial aid to the geologist in these questions. In looking again at the points there set forth, I find they have not been invalidated by subsequent discoveries, and that we are still nearly in the same position with respect to these great questions that we were in at that time, — a singular proof of the impotency of that deductive method of reasoning which has become fashionable among naturalists of late. Yet the discussions of recent years have thrown some additional light on these matters; and none more so than the mild disclaimers with which my friend Dr. Asa Gray and other moderate and scientific evolutionists have met the extreme views of such men as Romanes, Haeckel, Lubbock, and Grant Allen. It may be useful to note some of these as shedding a little light on this dark corner of our unsolved problems.

It has been urged on the side of rational evolution, that this hypothesis does not profess to give an explanation of the absolute origin of life on our planet, or even of the original organization of a single cell or of a simple mass of protoplasm, living or dead. All experimental attempts to produce by synthesis the complex albuminous substances, or to obtain the living from the non-living, have so far been fruitless; and, indeed, we cannot imagine any process by which such changes could be effected. That they have been effected we know; but the process employed by their maker is still as mysterious to us as it probably was to him who wrote the words, 'And God said let the waters swarm with swarmers.' How vast is the gap in our knowledge and our practical power implied in this admission, which must, however, be made by every mind not absolutely blinded by a superstitious belief in those forms of words which too often pass current as philosophy!

But if we are content to start with a number of organisms ready made, — a somewhat humiliating start, however, — we still have to ask, How do these vary so as to give new species? It is a singular illusion in this matter, of men who profess to be believers in natural law, that variation may be boundless, aimless, and fortuitous, and that it is by spontaneous selection from varieties thus produced that development arises. But surely the supposition of mere chance and magic is unworthy of science. Varieties must have causes, and their causes and their effects must be regulated by some law or laws. Now, it is easy to see that they cannot be caused by a mere innate tendency in the organism itself. Every organism is so nicely equilibrated, that it has no such spontaneous tendency, except within the limits set by its growth and the law of its periodical changes. There may, however, be equilibrium more or less stable. I believe all attempts hitherto made have failed to account for the fixity of certain, nay, of very many, types throughout geological time; but the mere consideration that one may be in a more stable state of equilibrium than another so far explains it. A rocking stone has no more spontaneous tendency to move than an ordinary bowlder, but it may be made to move with a touch. So it probably is with organisms. But, if so, then the causes of variation are external, as in many cases we actually know them to be; and they must depend on instability or change in surroundings, and this so arranged as not to be too extreme in amount, and to operate in some determinate direction. Observe how remarkable the unity of the adjustments involved in such a supposition. How superior they must be to our rude and always more or less unsuccessful attempts to produce and carry forward varieties and races in definite directions! This cannot be chance. If it exists, it must depend on plans deeply laid in the nature of things, else it would be most monstrous magic and causeless miracle. Still more certain is this conclusion when we consider the vast and orderly succession made known to us by geology, and which must have been regulated by fixed laws, only a few of which are as yet known to us.

Beyond these general considerations, we have others of a more special character, based on paleontological facts, which show how imperfect are our attempts, as yet, to reach the true causes of the introduction of genera and species.

One is the remarkable fixity of the leading types of living beings in geological time. If instead of framing, like Haeckel, fanciful phylogenies, we take the trouble, with Barrande and Gaudry, to trace the forms of life through the period of their existence, each along its own line, we shall be greatly struck with this, and especially with the continuous existence of many low types of life through vicissitudes of physical conditions of the most stupendous character, and over a lapse of time scarcely conceivable. What is still more remarkable is, that this holds in groups which, within certain limits, are perhaps the most variable of all. In the present world no creatures are individually more variable than the protozoa; as, for example, the foraminifera and the sponges. Yet these groups are fundamentally the same, from the beginning of the palaeozoic until now; and modern species seem scarcely at all to differ from specimens procured from rocks at least half-way back to the beginning of our geological record. If we suppose that the present sponges and foraminifera are the descendants of those of the Silurian period, we can affirm, that, in all that vast lapse of time, they have, on the whole, made little greater change than that which may be observed in variable forms at present. The same remark applies to other low animal forms. In forms somewhat higher and less variable, this is equally noteworthy. The pattern of the venation of the wings of cockroaches, and the structure and form of land-snails, gally-worms, and decapod crustaceans, were all settled in the carboniferous age in a way that still remains. So were the foliage and the fructification of club-mosses and ferns. If at any time members of these groups branched off, so as to lay the foundation of new species, this must have been a very rare and exceptional occurrence, and one demanding even some suspension of the ordinary laws of nature.

Certain recent utterances of eminent scientific men in England and France are most instructive with reference to the difficulties which encompass this subject. Huxley, at present the leader of English evolutionists, in his 'Rede lecture'[1] delivered at Cambridge, England, holds that there are only two 'possible alternative hypotheses' as to the origin of species, — (1) that of 'construction,' or the mechanical putting-together of the materials and parts of each new species separately; and (2) that of 'evolution,' or that one form of life 'proceeded from another' by the 'establishment of small successive differences.' After comparing these modes, much to the disadvantage of the first, he concludes with the statement that "this was his case for evolution, which he rested wholly on arguments of the kind he had adduced;" these arguments being the threadbare false analogy of ordinary reproduction and the transformation of species, and the mere succession of forms more or less similar in geological time, neither of them having any bearing whatever on the origin of any species or on the cause of the observed succession. With reference to the two alternatives, while it is true that no certain evidence has yet been obtained — either by experiment, observation, or sound induction — as to the mode of origin of any species, enough is known to show that there are numerous possible methods, grouped usually under the heads of absolute creation, mediate creation, critical evolution, and gradual evolution. It is also true that almost the only thing we certainly know in the matter, is that the differences characteristic of classes, orders, genera, and species, must have arisen, not in one or two, but in many ways. An instructive commentary on the capacity of our age to deal with these great questions is afforded by the fact that this little piece of clever mental gymnastic should have been practised in a university lecture and in presence of an educated audience. It is also deserving of notice, that, though the lecturer takes the development of the Nautili and their allies as his principal illustration, he evidently attaches no weight to the argument in the opposite sense deduced by Barrande — the man of all others most profoundly acquainted with these animals — from the paleozoic cephalopods.

Another example is afforded by a lecture recently delivered at the Royal institution in London by Professor Flower.[1] The subject is, 'The whales, past and present, and their probable origin.' The latter point, as is well known, Gaudry had candidly given up. "We have questioned," he says, "these strange and gigantic sovereigns of the tertiary oceans as to their ancestors, — they leave us without reply." Flower is bold enough to face this problem; and he does so in a fair and vigorous way, though limiting himself to the supposition of slow and gradual change. He gives up at once, as every anatomist must, the idea of an origin from fishes or reptiles. He thinks the ancestors of the whales must have been quadrupedal mammals. He is obliged for good reasons to reject the seals and the otters, and turns to the ungulates, though here, also, the difficulties are formidable. Finally he has recourse to an imaginary ancestor, supposed to have haunted marshes and rivers of the mesozoic age, and to have been intermediate between a hippopotamus and a dolphin, and omnivorous in diet. As this animal is altogether unknown to geology or zoölogy, and not much less difficult to account for than the whales themselves,

[1] Report in *Nature*, June 21, corrected by the author.

[1] Reported in *Nature*.

he very properly adds, 'Please to recollect, however, that this is a mere speculation.' He trusts, however, that such speculations are 'not without their use;' but this will depend upon whether or not they lead men's minds from the path of legitimate science into the quicksands of baseless conjecture.

Gaudry, in his recent work, 'Enchainements du monde animal,'[1] though a strong advocate of evolution, is obliged in his final *résumé* to say, "Il ne laisse point percer le mystère qui entoure le developpement primitif des grandes classes du monde animal. Nul homme ne sait comment ont été formés les premiers individus de foraminifères, de polypes, d'étoiles de mer, de crinoides, etc. Les fossiles primaires ne nous ont pas encore fourni de preuves positives du passage des animaux d'une classe à ceux d'une autre classe."

Professor Williamson of Manchester, in an address delivered in February last before the Royal institution of Great Britain, after showing that the conifers, ferns, and lycopods of the paleozoic have no known ancestry, uses the significant words, "The time has not yet arrived for the appointment of a botanical king-at-arms and constructor of pedigrees."

Another caution which a paleontologist has occasion to give with regard to theories of life has reference to the tendency of biologists to infer that animals and plants were introduced under embryonic forms, and at first in few and imperfect species. Facts do not substantiate this. The first appearance of leading types of life is rarely embryonic. On the contrary, they often appear in highly perfect and specialized forms; often, however, of composite type, and expressing characters afterwards so separated as to belong to higher groups. The trilobites of the Cambrian are some of them of few segments, and, so far, embryonic; but the greater part are many-segmented and very complex. The batrachians of the carboniferous present many characters higher than those of their modern successors, and now appropriated to the true reptiles. The reptiles of the Permian and trias usurped some of the prerogatives of the mammals. The ferns, lycopods, and equisetums of the Devonian and carboniferous were, to say the least, not inferior to their modern representatives. The shell-bearing cephalopods of the paleozoic would seem to have possessed structures now special to a higher group, that of the cuttle-fishes. The bald and contemptuous negation of these facts by Haeckel and other biologists does not tend to give geologists much confidence in their dicta.

Again: we are now prepared to say that the struggle for existence, however plausible as a theory, when put before us in connection with the productiveness of animals, and the few survivors of their multitudinous progeny, has not been the determining cause of the introduction of new species. The periods of rapid introduction of new forms of marine life were not periods of struggle, but of expansion, — those periods in which the submergence of continents afforded new and large space for their extension and comfortable subsistence. In like manner it was continental emergence that afforded the opportunity for the introduction of land animals and plants. Further, in connection with this, it is now an established conclusion, that the great aggressive faunas and floras of the continents have originated in the north, some of them within the arctic circle; and this in periods of exceptional warmth, when the perpetual summer sunshine of the arctic regions co-existed with a warm temperature. The testimony of the rocks thus is, that not struggle, but expansion, furnished the requisite conditions for new forms of life, and that the periods of struggle were characterized by depauperation and extinction.

But we are sometimes told that organisms are merely mechanical, and that the discussions respecting their origin have no significance, any more than if they related to rocks or crystals, because they relate merely to the organism considered as a machine, and not to that which may be supposed to be more important; namely, the great determining power of mind and will. That this is a mere evasion, by which we really gain nothing, will appear from a characteristic extract of an article by an eminent biologist, in the new edition of the Encyclopedia Britannica, — a publication which, I am sorry to say, instead of its proper *rôle* as a repertory of facts, has become a strong partisan, stating extreme and unproved speculations as if they were conclusions of science. The statement referred to is as follows: "A mass of living protoplasm is simply a molecular machine of great complexity, the total results of the working of which, or its vital phenomena, depend on the one hand on its construction, and, on the other, on the energy supplied to it; and to speak of vitality as any thing but the name for a series of operations is as if one should talk of the horologity of a clock." It would, I think, scarcely be possible to put into the same number of words a greater amount of unscientific assumption and unproved statement than in this sentence. Is 'living protoplasm' different in any way from dead protoplasm, and, if so, what causes the difference? What is a 'machine'? Can we conceive of a self-produced or uncaused machine, or one not intended to work out some definite results? The results of the machine in question are said to be 'vital phenomena;' certainly most wonderful results, and greater than those of any machine man has yet been able to construct. But why 'vital'? If there is no such thing as life, surely they are merely physical results. Can mechanical causes produce other than physical effects? To Aristotle, life was 'the cause of form in organisms.' Is not this quite as likely to be true as the converse proposition? If the vital phenomena depend on the 'construction' of the machine, and the 'energy supplied to it,' whence this construction, and whence this energy? The illustration of the clock does not help us to answer this question. The construction of the clock depends on its maker, and its energy is derived from the hand that winds it up. If we can think of a clock which no one has made and which no one winds, — a clock constructed by chance, set in harmony with the universe by chance,

[1] Paris, 1883.

wound up periodically by chance, — we shall then have an idea parallel to that of an organism living, yet without any vital energy or creative law; but in such a case we should certainly have to assume some antecedent cause, whether we call it 'horologity' or by some other name. Perhaps the term 'evolution' would serve as well as any other, were it not that common sense teaches that nothing can be spontaneously evolved out of that in which it did not previously exist.

There is one other unsolved problem, in the study of life by the geologist, to which it is still necessary to advert. This is the inability of paleontology to fill up the gaps in the chain of being. In this respect, we are constantly taunted with the imperfection of the record; but facts show that this is much more complete than is generally supposed. Over long periods of time and many lines of being, we have a nearly continuous chain; and, if this does not show the tendency desired, the fault is as likely to be in the theory as in the record. On the other hand, the abrupt and simultaneous appearance of new types in many specific and generic forms, and over wide and separate areas at one and the same time, is too often repeated to be accidental. Hence paleontologists, in endeavoring to establish evolution, have been obliged to assume periods of exceptional activity in the introduction of species, alternating with others of stagnation, — a doctrine differing very little from that of special creation as held by the older geologists.

The attempt has lately been made to account for these breaks by the assumption that the geological record relates only to periods of submergence, and gives no information as to those of elevation. This is manifestly untrue. In so far as marine life is concerned, the periods of submergence are those in which new forms abound for very obvious reasons already hinted. But the periods of new forms of land and fresh-water life are those of elevation, and these have their own records and monuments, often very rich and ample; as, for example, the swamps of the carboniferous, the transition from the cretaceous subsidence to the Laramie elevation, the tertiary lake-basins of the west, the terraces and raised beaches of the pleistocene. Had I time to refer in detail to the breaks in the continuity of life, which cannot be explained by the imperfection of the record, I could show at least that nature, in this case, does advance *per saltum*, — by leaps, rather than by a slow continuous process. Many able reasoners, as LeConte in this country, and Mivart and Collard in England, hold this view.

Here, as elsewhere, a vast amount of steady conscientious work is required to enable us to solve the problems of the history of life. But, if so, the more the hope for the patient student and investigator. I know nothing more chilling to research, or unfavorable to progress, than the promulgation of a dogmatic decision that there is nothing to be learned but a merely fortuitous and uncaused succession, amenable to no law, and only to be covered, in order to hide its shapeless and uncertain proportions, by the mantle of bold and gratuitous hypothesis.

So soon as we find evidence of continents and oceans, we raise the question, "Have these continents existed from the first in their present position and form, or have the land and water changed places in the course of geological time?" In reality both statements are true in a certain limited sense. On the one hand, any geological map whatever suffices to show that the general outline of the existing land began to be formed in the first and oldest crumplings of the crust. On the other hand, the greater part of the surface of the land consists of marine sediments which must have been derived from land that has perished in the process, while all the continental surfaces, except, perhaps, some high peaks and ridges, have been many times submerged. Both of these apparently contradictory statements are true; and, without assuming both, it is impossible to explain the existing contours and reliefs of the surface.

In the case of North America, the form of the old nucleus of Laurentian rock in the north already marks out that of the finished continent, and the successive later formations have been laid upon the edges of this, like the successive loads of earth dumped over an embankment. But in order to give the great thickness of the paleozoic sediments, the land must have been again and again submerged, and for long periods of time. Thus, in one sense, the continents have been fixed; in another, they have been constantly fluctuating. Hall and Dana have well illustrated these points in so far as eastern North America is concerned. Professor Hull of the Geological survey of Ireland has recently had the boldness to reduce the fluctuations of land and water, as evidenced in the British Islands, to the form of a series of maps intended to show the physical geography of each successive period. The attempt is probably premature, and has been met with much adverse criticism; but there can be no doubt that it has an element of truth. When we attempt to calculate what could have been supplied from the old eozoic nucleus by decay and aqueous erosion, and when we take into account the greater local thickness of sediments towards the present sea-basins, we can scarcely avoid the conclusion that extensive areas once occupied by high land are now under the sea. But to ascertain the precise areas and position of these perished lands may now be impossible.

In point of fact, we are obliged to believe in the contemporaneous existence in all geological periods, except perhaps the very oldest, of three sorts of areas on the surface of the earth: 1. Oceanic areas of deep sea, which must always have occupied the bed of the present ocean, or parts of it; 2. Continental plateaus, sometimes existing as low flats or as higher tablelands, and sometimes submerged; 3. Areas of plication or folding, more especially along the borders of the oceans, forming elevated lands rarely submerged, and constantly affording the material of sedimentary accumulations.

Every geologist knows the contention which has been occasioned by the attempts to correlate the earlier paleozoic deposits of the Atlantic margin of North America with those forming at the same time on the interior plateau, and with those of intervening lines of plication and igneous disturbance. Stratigraphy, lithology, and fossils are all more or less at fault in dealing with these questions; and, while the general nature of the problem is understood by many geologists, its solution in particular cases is still a source of apparently endless debate.

The causes and mode of operation of the great movements of the earth's crust which have produced mountains, plains, and tablelands, are still involved in some mystery. One patent cause is the unequal settling of the crust toward the centre; but it is not so generally understood as it should be, that the greater settlement of the ocean-bed has necessitated its pressure against the sides of the continents in the same manner that a huge ice-floe crushes a ship or a pier. The geological map of North America shows this at a glance, and impresses us with the fact that large portions of the earth's crust have not only been folded, but bodily pushed back for great distances. On looking at the extreme north, we see that the great Laurentian mass of central Newfoundland has acted as a protecting pier to the space immediately west of it, and has caused the Gulf of St. Lawrence to remain an undisturbed area since paleozoic times. Immediately to the south of this, Nova Scotia and New Brunswick are folded back. Still farther south, as Guyot has shown, the old sediments have been crushed in sharp folds against the Adirondack mass, which has sheltered the tableland of the Catskills and of the Great Lakes. South of this again, the rocks of Pennsylvania and Maryland have been driven back in a great curve to the west. Nothing, I think, can more forcibly show the enormous pressure to which the edges of the continents have been exposed, and at the same time the great sinking of the ocean-beds. Complex and difficult to calculate though these movements of plication are, they are more intelligible than the apparently regular pulsations of the flat continental areas, whereby they have alternately been below and above the waters, and which must have depended on somewhat regularly recurring causes, connected either with the secular cooling of the earth, or with the gradual retardation of its rotation, or with both. Throughout these changes, each successive elevation exposed the rocks for long ages to the decomposing influence of the atmosphere. Each submergence swept away, and deposited as sediment, the material accumulated by decay. Every change of elevation was accompanied with changes of climate and with modifications of the habitats of animals and plants. Were it possible to restore accurately the physical geography of the earth in all these respects, for each geological period, the data for the solution of many difficult questions would be furnished.

It is an unfortunate circumstance, that conclusions in geology arrived at by the most careful observation and induction do not remain undisturbed, but require constant vigilance to prevent them from being overthrown. Sometimes, of course, this arises from new discoveries throwing new light on old facts; but when this occurs it rarely works the complete subversion of previously received views. The more usual case is, that some over-zealous specialist suddenly discovers what seems to him to overturn all previous beliefs, and rushes into print with a new and plausible theory, which at once carries with him a host of half-informed people, but the insufficiency of which is speedily made manifest.

Had I written this address a few years ago, I might have referred to the mode of formation of coal as one of the things most surely settled and understood. The labors of many eminent geologists, microscopists, and chemists in the old and the new worlds had shown that coal nearly always rests upon old soil surfaces penetrated with roots, and that coal-beds have in their roofs erect trees, the remains of the last forests that grew upon them. Logan and I have illustrated this in the case of the series of more than sixty successive coal-beds exposed at the South Joggins, and have shown unequivocal evidence of land-surfaces at the time of the deposition of the coal. Microscopical examination has proved that these coals are composed of the materials of the same trees whose roots are found in the underclays, and their stems and leaves in the roof-shales; that much of the material of the coal has been subjected to sub-aerial decay at the time of its accumulation; and that in this, ordinary coal differs from bituminous shale, earthy bitumen, and some kinds of cannel, which have been formed under water; that the matter remaining as coal consists almost entirely of epidermal tissues, which, being suberose in character, are highly carbonaceous, very durable, and impermeable by water,[1] and are hence the best fitted for the production of pure coal; and finally that the vegetation and the climatal and geographical features of the coal period were eminently fitted to produce in the vast swamps of that period precisely the effects observed. All these points and many others have been thoroughly worked out for both European and American coal-fields, and seemed to leave no doubt on the subject. But several years ago certain microscopists observed on slices of coal layers filled with spore-cases, — a not unusual circumstance, since these were shed in vast abundance by the trees of the coal-forests, and because they contain suberose matter of the same character with epidermal tissues generally. Immediately we were informed that all coal consists of spores; and, this being at once accepted by the unthinking, the results of the labors of many years are thrown aside in favor of this crude and partial theory. A little later, a German microscopist has thought proper to describe coal as made up of minute algae, and tries to reconcile this view with the appearances, devising at the same time a new and formidable nomenclature of generic and specific names, which would seem largely to represent mere fragments of tissues. Still later, some local facts in a French coal-field have induced an eminent botanist of that country to revive the drift theory of coal, in opposition to that of growth *in situ*. A year or two ago, when my friend Professor Williamson of Manchester informed me that he was preparing a large series of slices of coal with the view of revis-

[1] Acadian geology, third edition, supplement, p. 68.

ing the whole subject, I was inclined to say, that after what had been done by Lyell, Goeppert, Logan, Hunt, Newberry, and myself, this was scarcely necessary; but, in view of what I have just stated, it may be that all he can do will be required to rescue from total ruin the results of our labors.

An illustration of a different character is afforded by the controversy now raging with respect to the so-called fucoids of the ancient rocks. At one time the group of fucoids, or algae, constituted a general place of refuge for all sorts of unintelligible forms and markings; graptolites, worm-trails, crustacean tracks, shrinkage-cracks, and, above all, rill-markings, forming a heterogeneous group of fucoidal remains distinguished by generic and specific names. To these were also added some true land-plants badly preserved, or exhibiting structures not well understood by botanists. Such a group was sure to be eventually dismembered. The writer has himself done something toward this,[1] but Professor Nathorst has done still more;[2] and now some intelligible explanation can be given of many of these forms. Quite recently, however, the Count de Saporta, in an elaborate illustrated memoir,[3] has come to the defence of the fucoids, more especially against the destructive experiments of Nathorst, and would carry back into the vegetable kingdom many things which would seem to be mere trails of animals. While writing this address, I have received from Professor Crié of Rennes a paper in which he not only supports the algal nature of Rusichnites, Arthrichnites, and many other supposed fucoids, but claims for the vegetable kingdom even Receptaculites and Archaeocyathus. It is not to be denied that some of the facts which he cites, respecting the structure of the Siphoniae and of certain modern incrusting algae, are very suggestive, though I cannot agree with his conclusions. My own experience has convinced me, that, while non-botanical geologists are prone to mistake all kinds of markings for plants, even good botanists, when not familiar with the chemical and mechanical conditions of fossilization, and with the present phenomena of tidal shores, are quite as easily misled, though they are very prone, on the other hand, to regard land-plants of some complexity, when badly preserved, as mere algae. In these circumstances it is very difficult to secure any consensus, and the truth is only to be found by careful observation of competent men. One trouble is, that these usually obscure markings have been despised by the greater number of paleontologists, and probably would not now be so much in controversy were it not for the use made of them in illustrating supposed phylogenies of plants.

It would be wrong to close this address without some reference to that which is the veritable *pons asinorum* of the science, the great and much debated glacial period. I trust that you will not suppose, that, in the end of an hour's address, I am about to discuss this vexed question. Time would fail me even to name the hosts of recent authors who have contended in this arena. I can hope only to point out a few landmarks which may aid the geological adventurer in traversing the slippery and treacherous surface of the hypothetical ice-sheet of pleistocene times, and in avoiding the yawning crevasses by which it is traversed.

No conclusions of geology seem more certain than that great changes of climate have occurred in the course of geological time; and the evidence of this in that comparatively modern period which immediately preceded the human age is so striking that it has come to be known as pre-eminently the ice age, while, in the preceding tertiary periods, temperate conditions seem to have prevailed even to the pole. Of the many theories as to these changes which have been proposed, two seem at present to divide the suffrages of geologists, either alone, or combined with each other. These are, (1) the theory of the precession of the equinoxes in connection with the varying eccentricity of the earth's orbit, advocated more especially by Croll; and (2) the different distribution of land and water as affecting the reception and radiation of heat and the ocean-currents, — a theory ably propounded by Lyell, and subsequently extensively adopted, either alone or with the previous one. One of these views may be called the astronomical; the other, the geographical. I confess that I am inclined to accept the second or Lyellian theory for such reasons as the following: 1. Great elevations and depressions of land have occurred in and since the pleistocene, while the alleged astronomical changes are not certain, more especially in regard to their probable effect on the earth; 2. When the rival theories are tested by the present phenomena of the southern polar region and the North Atlantic, there seem to be geographical causes adequate to account for all except extreme and unproved glacial conditions; 3. The astronomical cause would suppose regularly recurring glacial periods of which there is no evidence, and it would give to the latest glacial age an antiquity which seems at variance with all other facts; 4. In those more northern regions where glacial phenomena are most pronounced, the theory of floating sheets of ice, with local glaciers descending to the sea, seems to meet all the conditions of the case; and these would be obtained, in the North Atlantic at least, by very moderate changes of level, causing, for example, the equatorial current to flow into the Pacific, instead of running northward as a gulf stream; 5. The geographical theory allows the supposition not merely of vicissitudes of climate quickly following each other in unison with the movements of the surface, but allows also of that near local approximation of regions wholly covered with ice and snow, and others comparatively temperate, which we see at present in the north.

If, however, we are to adopt the geographical theory, we must avoid extreme views; and this leads to the inquiry as to the evidence to be found for any such universal and extreme glaciation as is demanded by some geologists.

[1] Footprints and impressions on carboniferous rocks, *Amer. journ. sc.*, 1873.

[2] Royal Swedish academy, Stockholm, 1881.

[3] Apropos des algues fossiles, Paris, 1883.

The only large continental area in the northern hemisphere supposed to be entirely ice- and snow-clad is Greenland; and this, so far as it goes, is certainly a local case, for the ice and snow of Greenland extend to the south as far as 60° N. latitude, while both in Norway and in the interior of North America the climate in that latitude permits the growth of cereals. Further, Grinnel Land, which is separated from North Greenland only by a narrow sound, has a comparatively mild climate, and, as Nares has shown, is covered with verdure in summer. Still further, Nordenskiöld, one of the most experienced arctic explorers, holds that it is probable that the interior of Greenland is itself verdant in summer, and is at this moment preparing to attempt to reach this interior oasis. Nor is it difficult, with the aid of the facts cited by Woeickoff and Whitney,[1] to perceive the cause of the exceptional condition of Greenland. To give ice and snow in large quantities, two conditions are required, — first, atmospheric humidity; and, secondly, cold precipitating regions. Both of these conditions meet in Greenland. Its high coast-ranges receive and condense the humidity from the sea on both sides of it and to the south. Hence the vast accumulation of its coast snow-fields, and the intense discharge of the glaciers emptying out of its valleys. When extreme glacialists point to Greenland, and ask us to believe that in the glacial age the whole continent of North America as far south as the latitude of 40° was covered with a continental glacier, in some places several thousands of feet thick, we may well ask, first, what evidence there is that Greenland, or even the antarctic continent, at present shows such a condition; and, secondly, whether there exists a possibility that the interior of a great continent could ever receive so large an amount of precipitation as that required. So far as present knowledge exists, it is certain that the meteorologist and the physicist must answer both questions in the negative. In short, perpetual snow and glaciers must be local, and cannot be continental, because of the vast amount of evaporation and condensation required. These can only be possible where comparatively warm seas supply moisture to cold and elevated land; and this supply cannot, in the nature of things, penetrate far inland. The actual condition of interior Asia and interior America in the higher northern latitudes affords positive proof of this. In a state of partial submergence of our northern continents, we can readily imagine glaciation by the combined action of local glaciers and great ice-floes; but, in whatever way the phenomena of the bowlder clay and of the so-called terminal moraines are to be accounted for, the theory of a continuous continental glacier must be given up.

I cannot better indicate the general bearing of facts, as they present themselves to my mind in connection with this subject, than by referring to a paper by Dr. G. M. Dawson on the distribution of drift over the great Canadian plains east of the Rocky Mountains.[2] I am the more inclined to refer to this, because of its recency, and because I have so often repeated similar conclusions as to eastern Canada and the region of the Great Lakes.

The great interior plain of western Canada, between the Laurentian axis on the east and the Rocky Mountains on the west, is seven hundred miles in breadth, and is covered with glacial drift, presenting one of the greatest examples of this deposit in the world. Proceeding eastward from the base of the Rocky Mountains, the surface, at first more than four thousand feet above the sea-level, descends by successive steps to twenty-five hundred feet, and is based on cretaceous and Laramie rocks, covered by bowlder clay and sand, in some places from one hundred to two hundred feet in depth, and filling up pre-existing hollows, though itself sometimes piled into ridges. Near the Rocky Mountains the bottom of the drift consists of gravel not glaciated. This extends to about one hundred miles east of the mountains, and must have been swept by water out of their valleys. The bowlder clay resting on this deposit is largely made up of local *débris*, in so far as its paste is concerned. It contains many glaciated bowlders and stones from the Laurentian region to the east, and also smaller pebbles from the Rocky Mountains; so that at the time of its formation there must have been driftage of large stones for seven hundred miles or more from the east, and of smaller stones from a less distance on the west. The former kind of material extends to the base of the mountains, and to a height of more than four thousand feet. One bowlder is mentioned as being forty-two by forty by twenty feet in dimensions. The highest Laurentian bowlders seen were at an elevation of forty-six hundred and sixty feet, on the base of the Rocky Mountains. The bowlder clay, when thick, can be seen to be rudely stratified, and at one place includes beds of laminated clay with compressed peat, similar to the forest beds described by Worthen and Andrews in Illinois, and the so-called interglacial beds described by Hinde on Lake Ontario. The leaf-beds on the Ottawa River, and the drift-trunks found in the bowlder clay of Manitoba, belong to the same category, and indicate that throughout the glacial period there were many forest oases far to the north. In the valleys of the Rocky Mountains opening on these plains there are evidences of large local glaciers now extinct, and similar evidences exist on the Laurentian highlands on the east.

Perhaps the most remarkable feature of the region is that immense series of ridges of drift piled against an escarpment of Laramie and cretaceous rocks, at an elevation of about twenty-five hundred feet, and known as the 'Missouri coteau.' It is in some places thirty miles broad and a hundred and eighty feet in height above the plain at its foot, and extends north and south for a great distance; being, in fact, the northern extension of those great ridges of drift which have been traced south of the Great Lakes, and through Pennsylvania and New Jersey, and which figure on the geological maps as the edge of the continental glacier, — an explanation obviously inappli-

[1] Memoir on glaciers, Geol. soc. Berlin, 1881. Climatic changes, Boston, 1883.

[2] SCIENCE, July 1, 1883.

cable in those western regions where they attain their greatest development. It is plain that in the north it marks the western limit of the deep water of a glacial sea, which at some periods extended much farther west, perhaps with a greater proportionate depression in going westward, and on which heavy ice from the Laurentian districts on the east was wafted south-westward by the arctic currents, while lighter ice from the Rocky Mountains was being borne eastward from these mountains by the prevailing westerly winds. We thus have in the west, on a very wide scale, the same phenomena of varying submergence, cold currents, great ice-floes, and local glaciers producing icebergs, to which I have attributed the bowlder clay and upper bowlder drift of eastern Canada.

A few subsidiary points I may be pardoned for mentioning here. The rival theories of the glacial period are often characterized as those of land glaciation and sea-borne icebergs. But it must be remembered, that those who reject the idea of a continental glacier hold to the existence of local glaciers on the high lands more or less extensive during different portions of the great pleistocene submergence. They also believe in the extension of these glaciers seawards and partly water-borne, in the manner so well explained by Mattieu Williams; in the existence of those vast floes and fields of current- and tide-borne ice whose powers of transport and erosion we now know to be so great; and in a great submergence and re-elevation of the land, bringing all parts of it and all elevations up to five thousand feet successively under the influence of these various agencies, along with those of the ocean-currents. They also hold, that, at the beginning of the glacial submergence, the land was deeply covered by decomposed rock, similar to that which still exists on the hills of the southern states, and which, as Dr. Hunt has shown, would afford not only earthy *débris*, but large quantities of bowlders ready for transportation by ice.

I would also remark, that there has been the greatest possible exaggeration as to the erosive action of land-ice. In 1865, after a visit to the alpine glaciers, I maintained that in these mountains glaciers are relatively protective rather than erosive agencies, and that the detritus which the glacier streams deliver is derived mostly from the atmospherically wasted peaks and cliffs that project above them. Since that time many other observers have maintained like views, and very recently Mr. Davis of Cambridge and Mr. A. Irving have ably treated this subject.[1] Smoothing and striation of rocks are undoubtedly important effects, both of land-glaciers and heavy sea-borne ice; but the levelling and filling agency of these is much greater than the erosive. As a matter of fact, as Newberry, Hunt, Belt, Spencer, and others have shown, the glacial age has dammed up vast numbers of old channels which it has been left for modern streams partially to excavate.

The till, or bowlder clay, has been called a 'ground moraine,' but there are really no alpine moraines at all corresponding to it. On the other hand, it is more or less stratified, often rests on soft materials which glaciers would have swept away, sometimes contains marine shells, or passes into marine clays in its horizontal extension, and invariably in its embedded bowlders and its paste shows an unoxidized condition, which could not have existed if it had been a sub-aerial deposit. When the Canadian till is excavated, and exposed to the air, it assumes a brown color, owing to oxidation of its iron; and many of its stones and bowlders break up and disintegrate under the action of air and frost. These are unequivocal signs of a sub-aqueous deposit. Here and there we find associated with it, and especially near the bottom and at the top, indications of powerful water-action, as if of land-torrents acting at particular elevations of the land, or heavy surf and ice action on coasts; and the attempts to explain these by glacial streams have been far from successful. A singular objection sometimes raised against the sub-aqueous origin of the till is its general want of marine remains, but this is by no means universal; and it is well known that coarse conglomerates of all ages are generally destitute of fossils, except in their pebbles; and it is further to be observed, that the conditions of an ice-laden sea are not those most favorable for the extension of marine life, and that the period of time covered by the glacial age must have been short, compared with that represented by some of the older formations.

This last consideration suggests a question which might afford scope for another address of an hour's duration, — the question how long time has elapsed since the close of the glacial period. Recently the opinion has been gaining ground that the close of the ice age is very recent. Such reasons as the following lead to this conclusion: the amount of atmospheric decay of rocks and of denudation in general, which have occurred since the close of the glacial period, are scarcely appreciable; little erosion of river-valleys or of coast-terraces has occurred. The calculated recession of waterfalls and of production of lake-ridges lead to the same conclusion. So do the recent state of bones and shells in the pleistocene deposits, and the perfectly modern facies of their fossils. On such evidence the cessation of the glacial cold and settlement of our continents at their present levels are events which may have occurred not more than six thousand or seven thousand years ago, though such time estimates are proverbially uncertain in geology. This subject also carries with it the greatest of all geological problems, next to that of the origin of life; namely, the origin and early history of man. Such questions cannot be discussed in the closing sentences of an hour's address. I shall only draw from them one practical inference. Since the comparatively short post-glacial and recent periods apparently include the whole of human history, we are but new-comers on the earth, and therefore have had little opportunity to solve the great problems which it presents to us. But this is not all. Geology as a science scarcely dates from a century ago.

[1] *Proc. Bost. soc. nat. hist.*, xxii. *Journ. geol. soc. Lond.*, Feb., 1883.

We have reason for surprise in these circumstances, that it has learned so much, but for equal surprise that so many persons appear to think it a complete and full-grown science, and that it is entitled to speak with confidence on all the great mysteries of the earth that have been hidden from the generations before us. Such being the newness of man and of his science of the earth, it is not too much to say that humility, hard work in collecting facts, and abstinence from hasty generalization, should characterize geologists, at least for a few generations to come.

In conclusion, science is light, and light is good; but it must be carried high, else it will fail to enlighten the world. Let us strive to raise it high enough to shine over every obstruction which casts any shadow on the true interests of humanity. Above all, let us hold up the light, and not stand in it ourselves.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

Kalmias and rhododendrons.

June 16 of the present summer I chanced to be floating down Crossweeksung Creek in my canoe; and, at a bend in the stream, found myself at the foot of a steep bluff some seventy feet high, which was densely covered with a luxuriant growth of kalmias and rhododendrons in full bloom. The former were laden with magnificent clusters of white, waxy flowers; and the more gorgeous pink rhododendron-blossoms were scattered through them. It was the most beautiful floral display I had ever seen.

On my return home, I turned to the description by Kalm of the smaller of these shrubs, to which Linné gave the generic name it now bears in honor of its discoverer. Kalm writes, "Linnaeus, conformable to the peculiar friendship and goodness which he has always honored me with, has been pleased to call this tree Kalmia." He further says, "The spoon-tree, which never grows to a great height, we saw this day in several places. The Swedes here have called it thus, because the Indians, who formerly lived in these provinces, used to make their spoons and trowels of the wood of this tree. In my cabinet of curiosities I have a spoon made of this wood by an Indian." Again he says, "About the month of May they begin to flower in these parts (central New Jersey), and then their beauty rivals that of most of the known trees in nature. The flowers are innumerable, and sit in great bunches," etc.

Kalm was visiting in New Jersey when he wrote the above; and it may be that where he was at the time (Swedesboro, Gloucester county), the rhododendron is not found. At all events, he nowhere mentions this shrub, which is here known as 'mountain laurel' to distinguish it from the true kalmia. In calling the latter the 'spoon-tree,' has he confounded the two? Certainly his remarks on the character of the wood, and the use to which it was formerly put by the Indians, lead to that conclusion. At present, it would be difficult to find a sufficiently large growth of kalmia to enable an Indian to whittle from it a spoon or trowel of respectable size. From rhododendron-stocks, implements of considerable size can be made; and Professor Kalm's description of kalmia wood is equally applicable to it. He describes it as "very hard, may be made very smooth, and does not easily crack or burst."

In Britton's Flora of New Jersey, Kalmia latifolia is called 'spoon-wood,' which name, I suppose, is derived from the remarks made by Kalm, as above quoted. I suggest that it is a misnomer, and that the remarks on the uses of the wood made by the distinguished Swedish naturalist refer really to the rhododendron.

Considering that Kalm was so careful an observer, was particularly interested in botany, and further, not only enjoyed the friendship of Bartram, but frequently visited him, in whose celebrated garden was a rhododendron-grove, it is strange that no mention is made, in his 'Travels in North America,' of the larger 'laurel,' so called; yet such appears to be the case.

This is an unimportant matter perhaps, but, if I am right, should not go uncorrected.

Charles C. Abbott, M.D.

Trick of the English sparrow.

A curious freak of the imported sparrow recently came to my notice at Basin Harbor, on Lake Champlain, in Vermont.

The eaves-swallows had attached their mud 'retorts,' as usual, in line under the eaves of the farmer's barn, anticipating, no doubt, a successful and happy house-keeping, notwithstanding a colony of feathered foreigners had encamped about the premises.

At sight of these 'bottle-nosed' dwellings, now arriving at completion, it occurred to the little tramps that these were exactly the thing they wanted; but, as the apartments were not to let, a battle ensued, which resulted in the rout of Lunifrons. The sparrows then took possession of the mud-houses, and furnished them to their own taste. But some of the 'masons' made a successful resistance, and still held the castle; so that often a swallow-family had their arch enemy at next door.

Thus in more ways than one does the impudent little urchin, which has come to us from over the sea, merit the name of *parasite*. Now that the bird has become not only a general nuisance, but a sore annoyance to our native and useful birds, it is no wonder if the cry goes up all over the land, '*The sparrow must be blotted out!*'

F. H. Herrick.

Achenial hairs of Senecio.

In a paper read before the American association for the advancement of science at Montreal, Professor Macloskie referred to the achenial hairs of some of the Compositae. The paper was afterward published in the *American naturalist* for January, 1883; and here we find a figure showing the tubes issuing from the hairs of Senecio. A beautiful experiment showing these tubes, or rather threads, can be made with the achenes of S. Douglasii. Scraping a few of the hairs from an achene, and placing them on a slide under the microscope with a two-thirds objective, and applying a drop of water to the slide, the threads are seen to uncoil. As soon as the water touches the hairs, the tips seem to burst, and allow the threads to emerge, rapidly twisting round and round in a very snake like manner. The experiment is a most satisfactory one, and can be readily made. These threads were noticed long ago, as Lindley (Veg. king., p. 701–705) speaks of Decaisne having seen them. Lindley says in regard to them, "On placing one of these papillae in water, it immediately separates into two lips, and these emit mucilaginous tubes, which issue forth like wires, spirally unrolling themselves, and finally much exceed the papillae from which they proceed. These tubes are apparently formed by a very considerable number of threads placed one upon the other in the manner of a skein of thread." I do not know of any explanation of the use of these threads. Can any of your readers suggest a purpose for them?

Jos. F. James.

Cincinnati, O., Aug. 2, 1883.

Seeds of Lepidium.

I regret to observe, by your issue of July 27, that my employment of the expression 'mucilaginous threads' as to the seeds of Lepidium has led your reviewer to understand that I referred to something like the seed-fibres of Collomia. Spiral fibres embedded in mucilage are found on the seeds of Collomia; radiating processes consisting of mucilage, each tipped by a facet of cuticle, are emitted by the seeds of Lepidium virginicum. This is shown on the application of water with staining-fluid to ripe seeds. Other species of Lepidium (including L. ruderale) show the same phenomenon, though the experiment may fail with immature seeds or old herbarium specimens.

G. Macloskie.

Princeton, N.J., Aug. 3, 1883.

["The exotest may bear long hairs (cotton) or spiral threads. . . . In Lepidium (pepper-grass), on being moistened, it darts out mucilaginous threads" It certainly may be gathered from this that the 'spiral threads' and the 'mucilaginous threads' are not the very same. But the darting-out of mucilaginous threads so well describes what one sees in Collomia-seeds and the like, and so poorly answers to what takes place in those of Lepidium, that the reviewer supposed there might be some mixing up of cases. But he simply asked whether the author was sure of the threads in Lepidium. We find nothing to which the name of 'mucilaginous threads' can with any exactness be applied; nor do we think that the term now used of 'radiating processes,' though not widely amiss, gives a clear idea of the case, which we should describe thus: —

A superficial pellicle of the seed-coat of Lepidium consists of a single and continuous layer of cells, the thick walls of which are at maturity converted into mucilage, or into an isomer of cellulose, which swells up into mucilage 'upon the application of water.' But the water acts so promptly in forming the *limbus* around the seed or its section, that we fail in that way to get an intelligible view of the structure and the nature of the process. To do this, however, we have only to soak thin sections of the seed in strong alcohol, examine in them the unaltered mucilage-cells, and then add a little water by degrees. The cells then swell up slowly, push outward radially (for mutual pressure prevents lateral expansion at the beginning), become wedge-shaped or pear-shaped as they farther protrude, and at length form the well-known mucilaginous *limbus*. Dr. Macloskie will be interested in repeating this experiment, and will accept our apology for partially misunderstanding him.]

KONKOLY'S ASTRONOMICAL INSTRUMENTS.

Praktische anleitung zur anstellung astronomischen beobachtungen, mit besonderen rücksicht auf die astrophysik, nebst einer modernen instrumentenkunde. Von Nicolaus von Konkoly. Braunschweig, *Vieweg*, 1883. 912 p., 345 illustr. 8°.

This is an important but at the same time a disappointing work. It contains the description and representation of nearly all the principal modern astronomical instruments, and presents such a comprehensive summary as can be found in no other existing book. The numerous illustrations, largely derived from the business catalogues of leading instrument-makers, are generally excellent, and the mechanical execution and press-work are admirable. Undoubtedly the book is one which must have a place in every astronomical library.

At the same time, the work is far from exhaustive, omitting all mention of many of the latest and most useful improvements; and it is not always accurate in its description of those it does notice. Nor does it deal in any thorough or satisfactory manner with the theory of the instruments described. It is so full and so good, that it is a great pity that it is not still better and still more complete, as it easily might have been.

The first chapter, on time-keepers (*uhren*), describes, among clock-escapements, only the old Graham dead-beat and a duplex of Jürgensen's. There is no notice of Airy's detached escapement, now in use at Greenwich, nor of any of the numerous and excellent gravity-escapements now so common in England and this country. The account of electric make and break circuit apparatus is for this reason unsatisfactory, since only escapements of the detached class admit of a simple break-circuit which does not affect the pendulum. The author treats the subject rather extensively, describing no less than twelve different forms of contact apparatus, some of them very elaborate and complicated. The antiquated contrivances of Locke and Mitchell are described as if they continued to be in use.

The second chapter, a short one, deals with the different forms of levels and level-testers, and appears to be in all respects satisfactory.

The third chapter treats of instruments for the determination of time. Under this head are included not only transits and transit-circles, but all forms of theodolites, sextants, passage-prisms, etc. There is also a certain amount of information respecting the graduation of circles and the methods of testing their accuracy, i.e., the optical and mechanical arrangements; the mathematical theory remaining untouched.

The next chapter, the fourth, is by far the most extensive and full of any, occupying two hundred and forty-six pages. It treats of equatorials and their mounting, and describes and illustrates nearly all the important modern telescopes. For the most part, it is well done, especially the portion relating to driving-clocks.

It is evident, however, that the author does not fully grasp all the principles involved in these machines, or he would hardly have spoken so disparagingly of the 'spring-governor' of Bond, which is unquestionably, when properly adjusted, one of the most perfect of all. In so full a treatment of the subject, one would naturally expect to find some notice of the ingenious arrangement by which the clock-work of the Dun Echt equatorial is brought under the electric control of the standard timepiece; but it is missing, though Grubb's less perfect apparatus for the same purpose is fully described.

The fifth chapter, dealing with micrometers, calls for no special notice, beyond the remark that it strikes one as a curious classification which treats of *chronographs* in this connection.

The sixth chapter is a short one, describing the different forms of helioscopes and solar eye-pieces, and the most convenient arrangements for making drawings of sun-spots and determining their position.

The seventh chapter is intended to be a full and elaborate description of the different forms of astronomical spectroscopes, with their accessories. It does describe and figure a great many; but there are several mistakes (as, for instance, on p. 656, where the temporary device which Professor Young employed in observing the eclipse of 1869 is said to have been used with a heliostat, and is spoken of as if it were now used at Princeton), and there is the capital omission of failing even to mention the use of diffraction-gratings in spectroscopic work. It strikes one as very surprising that the author should not have learned that for solar observations the grating has almost entirely supplanted the prism in many if not most observatories. The remarkable apparatus of Thollon is alluded to, but not described with any fulness.

The remaining chapters of the book treat of apparatus for celestial photography, photometry, and the measure of solar radiation.

Similar remarks apply to these as to the preceding. There are many excellent descriptions and illustrations, many important omissions, and a few mistakes. We call special attention to the fine representation of the most ingenious mounting — devised by Hansen, and constructed by Repsold — for the photoheliographs employed by the German transit of Venus parties, — a contrivance which we have never seen described elsewhere. But in the chapter on photography, neither the name of H. Draper nor of Common appears; and Rutherford's photographs of the spectrum are said (on p. 827) to have been made with an apparatus he never even saw, the instrument figured being a spectroscope which was used at Dartmouth college in attempting to photograph the solar prominences, while the description given is incorrect in several particulars. In the chapter on the measurement of radiation the apparatus of Pouillet and Secchi appears, but nothing later, — none of the instruments of Violle or Crova, and, of course, not the bolometer of Langley. The chapter on photometers is much better brought up to date.

On the whole, the book is rather a provoking one. There is a great deal in it of real value, collected from various more or less inaccessible sources, and very neatly presented; but the *lacunae* are serious, and a few detected mistakes leave a sense of insecurity as to accuracy in other details.

BURNHAM'S LIMESTONES AND MARBLES.

History and uses of limestones and marbles. With forty-eight chromolithographs. By S. M BURNHAM. Boston, *S. E. Casino & Co.*, 1883. 15 + 392 p. 8°.

THE separate crystals of our rocks, when they lend themselves to decoration in the form of gems, afford a capital opportunity for the book-maker. Superstition, tradition, a host of human activities, have gathered about them, that, in the hands of writers of skill, have been worked into very readable books. But, when the author of 'Limestones and marbles' tries to take something of the same book-maker's way with the coarser though still beautiful marbles, he leaves the field of thoroughly humanized things, and finds himself in a dreary sea of unrelated facts. A writer thoroughly conversant with the architectural history of building and ornamental stones could probably give us a book which would, from its connection with the most economic of the fine arts, be very readable. A skilled lithologist who would furnish us a careful discussion of the nature of those changes which give beauty, strength, and endurance to rocks, would thereby furnish us with a needed essay; but in this book we have no trace of these capacities, but only the ordinary patience of the devoted compiler.

As a piece of unwearied compilation, unenlivened with any higher quality, this is a very remarkable book. In the list of limestones of the United States we have evidence of a most universal but most uncritical ransacking of authorities; for the element of personal knowledge is entirely wanting. Nor has the compilation the value it might have had if authorities had been quoted. Although the book is apparently by a New-Englander, he omits the limestones of Smithfield, R.I., and the serpentines of Lynnfield, Mass., — both interesting, though, as yet, little-used stones. Any personal knowledge of the subject would have supplied a host of such facts, which are not to be found in books, though well known to geologists. The same absence of personal knowledge leads to such misleading statements as that the fossils around Prague are identical with those of the same age in Scandinavia, Russia, Great Britain, and North America. While the book is padded with thirty-eight pages on classification of fossils, nothing is given to the arts of quarrying or of dressing stones, — most important and most relevant matters.

The chromolithographic plates are fairly well done: they fail to give the peculiar effect of depth or translucency, which is beyond this art, but which is the greatest charm of the finest decorative stones.

The style is not altogether bad, though it is frequently inverted; and the author often gets into the subject very much as John Phoenix 'backed the transit' into the plane of the meridian. Now and then it is strikingly epigrammatic, as in the following phrase: 'One of the caprices of nature is to anticipate the works of art.'

It is a pity that so much faithful labor should have been given to this work. The printing of the book, and the index, are very satisfactory. Despite its defects, the book will have a certain value to those interested in the subject; for, as a compilation, it is, in its way, remarkable.

A PRIMER OF VISIBLE SPEECH.

Visible-speech reader for the nursery and primary school. By Alex. Melville Bell, F.E I S., etc. Cambridge, *King*, 1883. 4 + 52 p. 16°.

The science of phonetics made, perhaps, its greatest advance through Bell's Visible speech, though it has by no means remained stationary since that book appeared. It is this system which this primer seeks to bring into practical use in teaching, and its alphabet is a great improvement over that which we now use. It cannot be said, however, that the phonetic analysis on which it is based has received in all respects the approval of phoneticians. With some changes, the vowel system has now won wide acceptance, but the analysis of consonants has met with serious objections; for instance, for such sounds as *f*, *th*, *s*, *sh*, in English. A discussion of the system itself would necessitate reference to recent work on phonetics, especially to Sweet's paper on Sound notation in the Transactions of the philological society for 1880–81, and to Sievers's Grundzüge der phonetik, and such a discussion would hardly be in place here. One may wish, however, that some of Sweet's changes of the Visible-speech alphabet could have been adopted. Still, the imperfections of the system might never attract a child's notice, and he would probably accept unquestioningly the signs given for *f* and *th*, without understanding why they were made to resemble the sign for *l*. For the scientific study of living languages, and of the phenomena of linguistic change, some such phonetic system as Visible speech, we may hope, will be agreed upon, at least provisionally, whether it is found of practical value in teaching children to read or not. The test of practice must show whether this ingenious alphabet will do better than other phonetic primers the work of teaching a child to read ordinary printed books. The primer is divided into three parts, — first, pictured words, containing pictures of a few common objects, with their names and some phrases; next, sentences in rhythmical form; and lastly, a vocabulary of common words arranged according to the initial sound, beginning with labial consonants, and ending with vowels. All this is printed only in Visible-speech letters. These three parts are preceded by some directions to the teacher; and at the end a key is added for the teacher's use, containing the usual forms in Roman type of all the words in the primer. Exclusive of the key, the whole contains thirty-five pages. At the beginning of the key are given a few 'notes,' which speak of the syllabic *l* and *n*, as in *castle*, *listen*, and of the glides, that is, the vowel vanishes, or final diphthongal elements in such words as *hear* (the sound represented by *r*), *day*, *go*. It must surprise an American student of phonetics to see that American pronunciation is credited by Mr. Bell with pure long vowels in the last two of these words, instead of with diphthongs, especially if his own experience and observation with foreign languages have shown him how hard it is for most Americans to learn the pure long sounds of *e* and *o* as pronounced on the continent of Europe. Possibly the American vanishing vowel in these cases is less prominent than in England, and it may be that some Americans do pronounce simple long vowels in such cases. In this primer these two glides are not used with $\bar{a}$ and $\bar{o}$. To call the *r* glide, as in *hear*, a very soft *r* is misleading, as most of us in the eastern United States pronounce absolutely no *r* at all in such words.[1] Here, too, what is said of American pronunciation is inexact; for surely we all have an *r* glide in words like *hearing*, while an English reader of Mr. Bell's words would suppose that Americans pronounce *hear* as he does, but *hearing* like *he-ring*. The American rule for the *r* glide may be thus stated for some, perhaps most of us: when the *r* glide is present at the end of a word, it is retained before any ending of derivation or inflection, the consonant *r* being pronounced in addition after the glide if the ending begins with a pronounced vowel. Thus the glide is heard in *boor, boorish, beer, beery, soar, oaring, store, storing, stored;* but there is no *r* glide in *Mary, story, fury.* Cases like these last seem to have been excluded from the book.

[1] See Whitney, The elements of English pronunciation, in his Oriental and linguistic studies, second series.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

CHEMISTRY.

(General, physical, and inorganic.)

New explosive. — S. H. Hinde proposes a new explosive mixture composed of 64 parts of nitro-glycerine, 12 ammonium citrate, 0.25 ethyl palmitate, 0.25 calcium carbonate, 23 coal, 0.50 sodium carbonate. — (*Chem. techn. repert.*, 1883, 153.) C. E. M. [196

Compressed cartridges. — H. Güttler makes cartridges of compressed blasting-powder, which are bound together by dextrine. For this purpose he uses a hard burned charcoal (brown-red), which he claims has the formula $C_8H_4O_2$. The mixture of charcoal, sulphur, and nitre are incorporated with the solution of dextrine, corned in grains of one to two millimetres; and after drying they are pressed into perforated cylinders. These cylinders are then dried and shellacked. The reaction due to explosion is represented, when India nitre is used, by $C_8H_4O_2 + 8\,KNO_3 + 4\,S = 8\,CO_2 + 2\,H_2O + 8\,N + 2\,K_2SO_4 + 2\,K_2S$. — (*Chem. techn. repert.*, 1883, 154.) C. E. M. [197

Fulminating compound. — B. G. and F. L. Benedict have invented a mixture for use in primers, in place of fulminating mercury, consisting of 2 parts amorphous phosphorus, 8 of minium, and 2 of potassium chlorate. The oxides of mercury or manganese may be used in place of the minium. — (*Chem. techn. repert.*, 1883, 153.) C. E. M. [198

AGRICULTURE.

Soluble and insoluble phosphates. — In experiments on potatoes, Swanwick and Prevost obtained a larger yield on plots manured with superphosphate than on those manured with the same phosphate simply ground. A slight increase in the percentage of starch was observed in the potatoes manured with superphosphate. — (*Bied. centr.-blatt.*, xii. 250; *Trans. highl. agric. soc.*, 1882.) H. P. A. [199

Value of artificial butter. — There are, according to Ad. Mayer, three principal points to be regarded in judging of the worth of an article of diet; viz., harmlessness, taste, and physiological utility. That artificial butter is harmful can hardly be seriously claimed; while, as regards its taste, the very magnitude of the industry shows that the imitation is very successful. The physiological utility of artificial butter depends essentially on its digestibility; and on this point Mayer has experimented, using as subjects a man, and a boy nine years old. But slight differences were observed between natural and artificial butter; but the former was digested a trifle better. When the artificial butter was used in preparing potatoes, it proved to be almost uneatable; and the author suggests that this fact may prove of use in detecting the presence of the former. — (*Landw. vers.-stat.*, xxix. 215.) H. P. A. [200

Butt and tip kernels of corn. — The vegetation of the butt, central, and tip kernels of corn in the field has corroborated the results already published as gained in the greenhouse. The figures of vegetations stand as below: —

Planted.	Butt kernels.		Central kernels.		Tip kernels.	
	June 1	June 4.	June 1.	June 4.	June 1.	June 4.
1 A 1, May 16	446	533	551	581	564	600
1 A 2, "	478	531	515	564	564	583
1 A 3, "	497	558	490	570	500	549
1 A 4, "	428	496	463	560	519	587
1 A 5, "	362	467	456	526	428	526
Total vegetated	2211	2588	2485	2801	2575	2845
Total planted	3420	3420	3420	3420	3420	3420
Per cent vegetated . .	64	75	72	82	75	83

— (*N. Y. agric. exp. stat., bull.* xlvii.) H. P. A. [201

Chemistry of asparagin. — B. Schulze finds that asparagin is not decomposed to any notable extent by heating with water, even under a pressure of three to four atmospheres, and in the presence of acid plant-juices. Consequently, when fodders containing asparagin, of which there are many, are cooked, this substance is unaltered; and, since its nutritive value has been established, the knowledge of this fact is of some importance. When heated with alkalies, asparagin yields asparaginic acid and ammonia, while a portion of the acid is further acted on, and malic acid is formed. — (*Landw. vers.-stat.*, xxix. 233.) H. P. A. [202

METEOROLOGY.

Observations on Ben Nevis. — A permanent observatory is to be established at the summit of this mountain by the Scottish meteorological society. A road to the summit has been begun: the building will be erected this summer, and it is expected that regular observations will be made after Nov. 1. The records will be kept hourly, not only at the summit, 4,406 feet above sea-level, but also at Fort William, which is situated twenty-eight feet above the sea, and at the base of the mountain. Since June 1, 1881, simultaneous observations at these points have been made at frequent intervals of the day, in the summer-time, by Mr. and Mrs. C. L. Wragge, the former of whom made the ascent every day until the storms of October rendered this impossible. The results obtained have been discussed by Mr. Buchan sufficiently to warrant the permanent establishment of the observatory. — W. U. [203

The origin of lightning. — In explaining satisfactorily the phenomenon of lightning, a difficulty is encountered in accounting for the enormous electric tensions which are necessary to explain the great length of the spark often observed. The theory is advanced by A. Fick, that the high tensions are produced by the sudden concentration of electricity already existing in a free state. This concentration is caused by the formation of large drops of rain from the small vesicles of moisture existing in the clouds, by which the surface upon which the electricity exists is greatly diminished. The sudden formation of drops of water from the mass of aqueous vapor may be due to the advance of cold-air currents. The author endeavors to answer two objections which may be urged against his theory: 1. That in every rain-storm lightning ought to be seen; 2. That it ought to rain whenever it lightens. To the first objection he replies, that the drops may be formed gradually, and not suddenly, in which case the tensions would be dissipated gradually; and, to the second, that drops are always formed in connection with lightning, but that in falling to the earth they sometimes encounter a layer of dry air, and are absorbed in their passage. — (*Naturforscher*, June 23.) W. U. [204

GEOGRAPHY.

(*Arctic.*)

News from Bering Sea. — News to July 8 has been received from the North Pacific whaling-fleet. The promise of a late spring had been fulfilled to date. Large quantities of drift-ice were afloat in Bering Sea some distance south of Bering Strait as late as the end of June. The whalers had taken but few whales, — only nine for the whole fleet. St. Lawrence Bay did not open until July 1. The Leo, bound for Point Barrow to relieve the party at the U. S. international polar station, had arrived at Plover Bay July 5. During the last few days of June strong southerly winds prevailed, driving the ice northward, so that at least one of the steam-whalers was able to reach ten leagues north of Cape Lisburne. The Corwin had not arrived. The bark Mary and Susan had been nipped, and was leaking badly; and the steam-whaler Balaena had returned to Plover Bay with the loss of her propeller-blades. Most of the fleet met south of St. Paul Island, in latitude 57° N., in April, and were fast in the ice from forty to eighty days, encountering very heavy ice and severe cold. The whales in their northward migration passed Cape Chaplin about July 9. The bark Hunter had been injured by a serious fire in the forecastle. A small number of walrus had been taken in default of larger game. Notwithstanding the unfavorable spring, a few weeks suitable weather may change the conditions sufficiently to enable the fleet to make a fair season's catch; but it must be confessed that the prospect of this, as well as for the Leo's reaching Point Barrow, and securing the desired observations there, are not encouraging. — W. H. D. [205

(*Africa.*)

Revoil's journey to Somali-land. — M. G. Revoil, recently intrusted with the direction of an expedition to Somali-land by the French ministry of public instruction, left Zanzibar about the first of May. During detentions at Aden and Zanzibar, collections of natural history and ethnology were obtained, and the members of the party instructed in the methods of work. Friendly relations were established with several chiefs of the Somali coast, who were on an annual visit to Zanzibar, and recommendations to various tributary chieftains obtained from the sultan. M. Revoil intended to enter the country with Arab guides at Mogadoxo. and to ascend the Wabbi River to Geledi, whence, after a short stay, he would proceed to Gananeh on the Juba River, which he would endeavor to map, while obtaining collections of all kinds. After this the Juba would be ascended to the region of the Ugadines toward the west, or he would enter the Galla country toward Kaffa and Shoa, where it is thought the friendly relations of the French with King Menelik would insure him a favorable reception. It is expected that the journey will terminate by traversing the country to Harrar, and thence to Zeila on the Gulf of Aden. — (*Comptes rendus soc. géogr.*, no. 11.) W. H. D. [206

ZOÖLOGY.

Mollusks.

Existence of a shell in Notarchus. — Vayssière has demonstrated the existence of a minute internal spiral shell in Notarchus. Taken into consideration with a similar discovery by Krohn in Gasteropteron, the author thinks it very probable that both are persistent embryonic shells (in Notarchus it is about one-fiftieth as long as the animal itself), and that an analogous appendage will be found eventually in most tectibranchs, which, up to the present time, have been considered shell-less. — (*Journ. de conchyl.*, xxii. 4.) W. H. D. [207

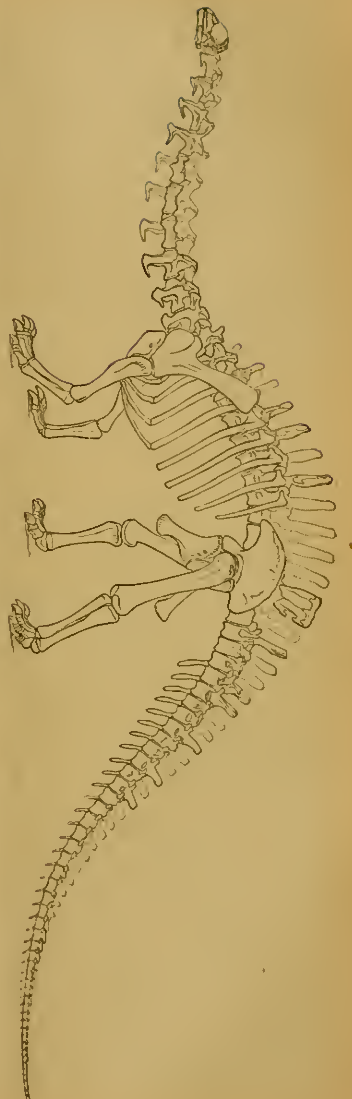
New abyssal mollusks. — Fischer describes a number of new species from the deep-sea dredgings of the Travailleur in 1882. They belong to the genera Dentalium, Mitra, Sipho, Pseudomurex, and Belomitra. The latter is a new genus resembling Bela, but with numerous small plications on the columella.

One species, Mitra cryptodon, comes from a depth of 1,900 metres in the Atlantic, — probably the greatest depth recorded for any species of that genus up to the present time. — (*Journ. de conchyl.*, xxii. 4.) W. H. D. [208

VERTEBRATES.

Reptiles.

Restoration of Brontosaurus. — In the continuation of his papers on Sauropoda, Marsh gives the accompanying restoration of Brontosaurus almost entirely from a single individual about fifty feet long. "The head was remarkably small; the neck was long, and, considering its proportions, flexible, and was the lightest portion of the vertebral column; the body was quite short, and the abdominal cavity of moderate size; the legs and feet were massive, and the bones all solid; the feet were plantigrade, and each footprint must have been about a square yard in extent; the tail was large, and nearly all the bones solid." Special attention is drawn to the head, which is "smaller in proportion to the body than in any vertebrate hitherto known," the entire skull weighing and measuring less than the fourth or fifth cervical vertebra. The animal is estimated to have weighed more than twenty tons, was more or less amphibious, probably fed on aquatic plants, and was doubtless a 'stupid, slow-moving reptile,' wholly wanting any offensive or defensive weapons. — (*Amer. journ. sc.*, Aug.) [209



RESTORATION OF BRONTOSAURUS.

Mammals.

Influence of pressure on heart-beat. — Many observers have noticed that the mammalian heart, after the death of the animal, will, under certain conditions, continue to beat spontaneously for some hours, especially if artificial inflation of the lungs is kept up. Ewald and Kobert have made some observations on this subject, inflating the heart directly with air, and find that hearts which have ceased to beat spontaneously, or after the application of mechanical stimuli, will again give contractions when the pressure within their cavities is raised. They come to the conclusion that one of the conditions which the blood must fulfil, in order to maintain the heart in activity, is, that it must exert a certain pressure on the heart-walls. — (*Pflüger's archiv*, xxxi. 187.) W. H. H. [210

Epiphyses on the centra of the vertebrae of the manatee. — M. Albrecht describes these rudimentary epiphyses at length. He believes that the presence of crests and furrows upon the intervertebral faces is a sure indication of epiphyses; but he goes further, and describes these processes. They are 'partially ossified in a peripheral zone, particularly in the dorsal region.' He also forms the hypothesis that the epiphyses are the remnants of more perfect ones, basing it upon the fact of the presence of the ridges and grooves upon the faces of the centra. — (*Bull. mus. hist. nat Belg.*, ii. 1883, 38.) F. W. T. [211

ANTHROPOLOGY.

The skulls of assassins. — A short time since, attention was called to the investigations made upon criminals and delinquents, with a view to study the early stages of humanity. The discussion is kept up by the French society, and most elaborate measurements are reported. M. Dally is not quite satisfied with the methods, however, and makes the following remarks. It is very wrong to confound things different *inter se* under one abstract term, and to study them as a natural group. Assassins, murderers, criminals, and even the assassinated, constitute juridical categories; but surely they are not philosophic. Highwaymen, ravishers, the jealous, monomaniacs, avengers, nihilists, etc., may be assassins; yet they have nothing in common, except that their actions lead to the same result. The organic conditions which lead to murder are quite different in each case. Again: every one knows that nothing is more rare than a perfectly symmetrical skull. Before establishing the proportions of anomalous crania among criminals, it is necessary to fix the standard among the virtuous. In fact, all men who have heavy lower jaws are not necessarily assassins; nor can we assume that all crime is evidence of atavism, and argue, hence, that in the anatomy of murderers we have the portraits of our prehistoric ancestors. — (*Bull. soc. anthrop. Paris*, v. 778.) J. W. P. [212

Easter Island. — Commander Bouverie F. Clark, in June last, visited the Easter Island, landing at the village of Malaveri, where the vessel was boarded by Mr. Alexander Salmon, agent of the Maison Brander of Tahiti, who purchased the property of the missionaries four years ago. The latter then left for the Gambier Archipelago, taking three hundred natives with them. The natives now number a hundred and fifty, and are decreasing. About five hundred were shipped to Tahiti eight years ago, to work on the plantations of the Maison Brander. Among the remaining people are no traces of the missionary work. They are divided into several small clans; and their chief quarrels are about the first eggs of the 'wide-awake' every year from Needle rock. The myth or tradition of their arrival is given by Commander Clark, who also speaks hopefully of the fertility of the island, as well as its value as a provision station. — (*Proc. roy. geogr. soc.*, v. 40.) J. W. P. [213

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

PUBLIC AND PRIVATE INSTITUTIONS.

University of Michigan.

Central laboratory for microscopy and general histology. — Instruction is given in this laboratory in the following subjects. 1. Microscopical technics, or the science and art of microscopy, comprising, (*a*) the theory and construction of the instrument and its various accessories; (*b*) the methods of determining magnifications; (*c*) the methods of microscopic drawing, microscopic photography, and microscopic projections; (*d*) the preparation of objects of various classes. 2. Human histology. 3. Comparative histology. 4. Vegetable histology. 5. Dental histology. 6. Pathological anatomy. 7. Completion of microscopic study in such other subjects as may be desired by professors in charge.

The following is the plan pursued in the principal divisions: —

Normal human histology. — This course consists of thirty lectures in the amphitheatre on the use of the microscope and on histology. In laboratory work the student is taught the manipulation of the instrument, use of accessories, etc. Then follows the study of such subjects as blood, epithelium, bone, tooth, cartilage, elastic tissue, muscle, kidney, stomach, liver, intestine, brain, spinal cord, and various miscellaneous subjects, as the oesophagus, tongue, skin, etc. The students are given instruction in mounting, so that each specimen is preserved as it is studied. The average number of mounts per student is about twenty. Each student is required to have at least twelve mounts, and some ambitious ones mount as high as fifty or sixty. Over six thousand mounts are carried away each year by students in this department. The object of the course is, first, to make the student better acquainted with the structure of tissues, and, second, that he may become familiar enough with the microscope and its manipulations to work to advantage without the aid of an instructor.

Vegetable histology. — The first course consists of work in structural botany for a term of twenty weeks. Special attention is given to the correct representation of microscopic objects on paper. Sixty accurate drawings of the various structures examined during the course are required of each student, the specimens being prepared by the students themselves. Vegetable protoplasm is studied with the special view of ascertaining the effects of the various reagents employed in general laboratory work. Then follow lessons on the vegetable cells, diatoms, and other miscellaneous subjects.

Course two in vegetable histology consists of work in pharmaceutical botany, three forenoons of laboratory work each week for twenty weeks. At the close of the course each student chooses a particular drug, studies it thoroughly, and presents the results of his labors in the form of a thesis.

Advanced normal and pathological histology. — Any student who has completed the primary course in the histological laboratory, or who has performed an equivalent amount of work in some other institution, can enter the class for advanced work. The first work here is in testing objectives with test-plates and diatoms, and in becoming more familiar with a few useful accessories. The art of injecting is then taken up, and the frog and cat are experimented upon, as well as individual organs from larger animals. Each student then chooses some particular organ or tissue, and prepares it in as many ways as possible for study. He thus becomes familiar with the various methods of hardening, cutting, and staining. Pathological structures are now carefully studied. This includes the study of inflammation and its results, the study of diseased organs and tissues, and of the non-inflammatory new formations.

Embryology. — A study of the development of the chick, including microscopic sections of the same.

Urinalysis. — A course of six weeks in the chemical analysis of the urine, including the use of the microscope in determining the character of the various deposits and crystals.

NOTES AND NEWS.

Dr. H. Newell Martin, professor of biology in Johns Hopkins university, has been appointed Croonian lecturer of the Royal society of London for the current year. The Croonian lecture was founded by Lady Sadlier, in fulfilment of a plan of her former husband, Dr. Croone, one of the founders and the first registrar of the Royal society. By her will, made in 1701, she devised "one-fifth of the clear rent of the King's-Head Tavern, in or near Old Fish Street, London, at the corner of Lambeth Hill, to be vested in the Royal society, for the support of a lecture and illustrative experiment on local motion." For many years past there has been no formal delivery of the lecture. The council of the Royal society select from the papers presented to them during the preceding twelve months that one dealing with animal motion which they think most noteworthy, and publish it as the Croonian lecture, sending to the author the sum derived from Lady Sadlier's bequest. The amount of money is trivial, but the appointment as Croonian lecturer is a highly prized distinction. The paper by Professor Martin, which is to be printed as the Croonian lecture for 1883, is on the Effect of changes of temperature on the beat of the heart. It is interesting to note that the first Croonian lecture, delivered by Dr. Stuart in 1738, was on the Motion of the heart.

— *Nature* of Aug. 2 prints the following telegram from the Swedish party which wintered at Spitzbergen, and was last heard from in October. "Cape Thordsen, July 4, 1883. This message will be forwarded to-morrow to Capt. Startschin, with the boat fetching our first mail this year. The wintering of the expedition has in every respect been attended with success, particularly as the scientific researches have throughout been carried on exactly in accordance with the regulations formulated by the International polar commission. Hydrographical and magnetic studies have also been pursued on the ice in the Ice Fjord, as well as parallax measurements of clouds, and observations as to the temperature of the air, the snow, and the earth. The winter has, on the whole, been mild; the greatest cold occurring on Jan. 2, when the thermometer registered 35.5° C. below freezing-point. Storms have been few. Since September last the following buildings have been erected: a hut on a mountain at an elevation of 270 metres, containing the anemometer and the windfan, which were read by a self-registering electrical apparatus; two astronomical observatories; another magnetic hut; a bath-house, a forge, and a wood storehouse. The dwelling-house and working-room have also been enlarged. The following game was shot during the winter: 61 ptarmigans, 9 reindeer, 18 wild geese, 20 foxes, and some wild fowl. With continuous labor, plenty of food and drink, and frequent baths, the members of the expedition have throughout enjoyed excellent health. Descriptions of the nature of our labor and life here during the wintering will follow."

— The new biological laboratory of the Johns Hopkins university, which will be opened next September, has been especially constructed with reference to providing opportunity for advanced work in experimental physiology. It contains two large rooms for general advanced work in animal physiology, in addition to others specially designed for work with the spectroscope, with the myograph, for electrophysiological researches, and for physiological chemistry. It also contains a special room constructed for advanced histological work, and well supplied with apparatus and reagents, a room for microphotography, and rooms for advanced work in animal morphology.

Prof. C. H. F. Peters of Clinton, N.Y., announces to Harvard college observatory the discovery of a new planet by him on the night of Aug. 12. Its position at time of discovery was as follows: Aug. 12, 13 hours, 49 minutes, 27 seconds, Clinton mean time; right ascension, 21 hours, 20 minutes, 48.17 seconds; declination, south, 12 degrees, 29 minutes, 8.2 seconds. The daily motion of the object is − 36 seconds in right ascension, and in declination 20 minutes and 50 seconds south. It is unusually bright for an asteroid, being of the ninth magnitude.

— The *Nation* for Aug. 2 calls attention to a very interesting feature of the table of ages (table XLII.) in the compendium of the tenth census. The table exhibits an astonishing preponderance of persons whose age is a 'round number,' i.e., a multiple of five or ten. One of the instances mentioned is, that while, according to the table, there are 1,094,324 persons at the age of 30, there are only 621,852 persons of 29 years, and only 492,530 persons of 31 years. There is a less powerful but still very marked and constant attraction to even numbers as compared with odd: for example, 42 claims 458,949, while 43 is content with 384,259; 47 is credited with 349,512, but 48 with 400.549. These are from the table of aggregates for the United States. The peculiarities are, of course, much more strongly marked in the columns referring to the classes and localities where there is most ignorance. Thus the number of the colored females in Mississippi who are put down as 30 years of age is 10,619, while the years immediately preceding and following are given only 2,253 and 1,236 respectively.

The writer of the interesting note in the *Nation* attributes the phenomenon to conjectural statements by people who did not know their own ages; but probably only a small part of it is due to that cause, at least in the more intelligent portions of the population. In so intelligent a state as Rhode Island, for instance, we find for the years 29, 30, 31, the numbers 3,965, 6,550, 3,112; which is not much better than in the aggregate of the United States. How much is due to guessing by relatives, servants, masters, etc., and especially to suggestions and guesses by the census-gatherers themselves, — who, of course, do not regard the exact ages as important, and most of whom have probably no strong views on the subject of the 'personal equation,' — no one can tell, but probably very much more than to people's ignorance of their own ages. An examination and comparison of the original note-books of the various census-takers would furnish materials for an interesting exercise, if nothing more, in statistical research, and might reveal approximately the extent to which the personal qualities of the census-takers has affected the result; while a comparison of the table with well-established tables of mortality might enable us to estimate the force of the tendency to understate age which would doubtless be found to exist. The whole thing makes a very pretty problem, and serves to illustrate in a rather gross and exaggerated way the complexity of statistical investigations.

—We learn from *Nature* that a meeting which may have an important result upon science and art instruction in England has been inaugurated at Manchester. An association has been established to effect the general advancement of the profession of science and art teaching by securing improvements in the schemes of study, and the establishment of satisfactory relations between teachers and the Science and art department, the city and guilds of London institute, and other public authorities. It proposes also to collect such information as may be of service to teachers professionally; and it will endeavor, by constant watchfulness, to advance the status and material interests of science and art teachers in all directions. The president of the new association is Professor Huxley, and the vice-presidents are Dr. H. E. Roscoe, Mr. Norman Lockyer, Professor Boyd Dawkins, Professor Gamgee, Professor Ayrton, Professor Silvanus Thompson, Dr. John Watts, Mr. S. Leigh-Gregson, Mr. John Angell, Mr. W. Lockett Agnew, Mr. C. M. Foden, and Mr. J. H. Reynolds. Mr. W. E. Crowther, of the Technical school and mechanic's institution, Manchester, is the honorary secretary; and all communications should be addressed to him, especially by those who are desirous of forming affiliated unions in other districts. We believe that branches are already being established at Newcastle-upon-Tyne and Liverpool.

—The attorney-general of the United States has approved the title to the proposed site of the fish-commission establishments at Wood's Holl, Mass.; and the contracts for the work on the breakwater, pier, and basin, will, it is expected, soon be made.

—King's Dictionary of Boston, after the manner of Dickens's Dictionary of London, has recently been published. Edwin M. Bacon is the editor. A short introduction is written by George E. Ellis, D.D. The brief notices of the libraries and scientific associations of Boston are satisfactory, and well brought down to date.

—For the last two years a couple of buck mountain sheep have been running with the flock of Mr. Bailey of Bull Run Basin, Nevada; and there are now between twenty and thirty half-breed lambs in the lot. According to the Tuscarora mining news, they are mostly covered with hair, although there is some wool amongst it. They carry their heads high, like the wild sheep, but are as easily herded as those of pure domestic blood. They are of no value for shearing, but are said to make excellent mutton.

—The subsidence of land in the Cheshire salt-districts of England is again becoming alarming. The bed of the river Weaver has widened out below Northwich, forming a lake of about two miles square, called the Flashes. Crater-like holes suddenly fall in, forming in a day or two deep ponds of saltish water. In one instance, two years ago, the river itself flowed backwards into the subsidence for the space of two minutes, filling up several old rock-salt mines in the neighborhood: from these the water is now pumped, and used as brine. Land-owners in the neighborhood brought a bill into Parliament during the session of 1882, to obtain compensation for the damage done by the salt-works; but it was argued that subsidence would occur by natural filtration, even if the brine were unworked, and the bill was thrown out.

—Mr. Albert Marth, F.R.A.S., has succeeded Dr. W. Doberck as astronomer at Col. Cooper's observatory, Markree, Ireland.

RECENT BOOKS AND PAMPHLETS.

Albert-Levy. Les nouveautés de la science. Paris, *Hachette*, 1883. 192 p. 18°.

Alvarez, Llanos, C. Electricidad estática. Madrid, *libr. militar*, 1883. 238 p., illustr. 8°.

Bell, A. Melville. Visible-speech reader for the nursery and primary school. Cambridge, *King*, 1883. 4+52 p. 16°.

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SCIENCE.

FRIDAY, AUGUST 24, 1883.

THE LESSONS OF THE MEETING.

The question as to the distance from the eastern seaboard to which the American association for the advancement of science can carry its annual assemblages is partly solved by the meeting at Minneapolis. That has registered about three hundred members in attendance; a small number, indeed, as compared with the Boston and Montreal meetings, but larger than was at first anticipated. One-third came from the Atlantic and New-England states. Astronomy and physics are fairly represented in the list; geology, as was expected, claimed the largest proportion; of botanists, there were over twenty-five — this was a surprise; the ethnologists were in considerable force; in all other branches of science, the attendance was somewhat meagre.

This, therefore, has not been one of the large meetings. Its addresses and papers have not contained any very striking feature that appealed to the interest of the general public. On the other hand, all that was presented, with few exceptions, though not brilliant, was above mediocrity. Looking over the list of papers, we find fewer than usual of the kind that brings sorrow to the hearts of scientific students; that provokes the question, How did such things ever pass the standing and sectional committees?

The merits and the disadvantages of the present system of conducting these meetings have been placed in very sharp light. Excellent addresses were delivered by most of the presidents of sections; in fact, these productions this year are a credit to the association. But the strain of obtaining such representative addresses from so many sections will soon be apparent: it may prove difficult to find the men to deliver them, within a very few years, especially if the number of sections continues to increase. The delivery of two or more of these addresses simultaneously, and the completion of the delivery of all of them in one afternoon, was felt to be a matter of grave injustice, both to speakers and hearers. To our readers we shall offer the only remedy now possible for this injustice, by printing the addresses in full, and by detachments.

Local committees, in cities to which the association will hereafter be invited, may learn some valuable lessons from the experience at Minneapolis. There was no lack of hospitable intention: the hearty courtesies of a western community were liberally extended. But the generous intentions were not carried out in the minor details that are essential to comfort if not to success. The meetings were held at a distance from the city, at the extreme end of a one-horse car route. Consequently the conveyances were overcrowded, much time was lost in going and coming, and — worse than all — few of the citizens of Minneapolis attended the sessions. We do not remember a meeting of the association at which the local interest, so far as audiences indicate it, was so deficient. The hotel selected for headquarters was not agreeable, because not exactly suitable. Members scattered to distant points, finding delicious havens of rest and recreation at summer-hotels on the lakes, but having to take yet longer time to attend the daily sessions. Free railroad transportation was provided to these distant resorts, but there was a confusing uncertainty about late trains that caused many embarrassments. These things may be trifles, but they are apt to be remembered when the lavishness of entertainment is forgotten.

As was anticipated, the association has chosen Philadelphia for its next session, where we may look again for the great numbers which attended the Boston and Montreal meetings. The exact date for holding it has been wisely left in the hands of the executive board, pending the choice of time by the British association for their Montreal meeting. A preference, however, has been indicated for the week beginning Sept. 3, — a date earlier than usual, but welcome to all who know how warm Philadelphia can be in August.

W. C. W.

RELIABILITY OF THE EVIDENCE OBTAINED IN THE STUDY OF CONTAGIA.

There is certainly a disposition, among some of our scientific men, to doubt the possibility of making direct and satisfactory demonstrations of the *rôle* played by the schizophytes, or microbia, in the production of disease, and that which they may be compelled to take in its prevention. Recent publications by accepted authorities have tended rather to confirm these doubts than to remove them, and we are frequently asked if our results are not founded on probabilities rather than on definite and conclusive facts. While this uncertainty is still felt, it is well to occasionally review the connection between the facts established and the conclusions drawn from them.

Though the schizophytes are the smallest of living organisms, that is not an insurmountable obstacle to their careful study, as is proved by the well-known investigations of the Bacillus anthracis by Koch. His demonstration that this exists in two forms (a vegetating filament and a spore), and that the latter survives unfavorable conditions which destroy the former, enabled him to trace a connection between the activity of the virus and the life of the parasite, which other investigators had failed to establish. Thus, the blood of anthrax victims, which contained only Bacillus rods, lost its power to reproduce the disease after a few days' putrefaction; while that which contained spores remained virulent an indefinite time. A certain degree of cold, and also an insufficient supply of oxygen, prevent the formation of spores; and, the filaments being short-lived, the organism loses its vitality in a few days under such conditions. If spores had formed before the liquid was exposed to these conditions, however, they were unaffected, and were capable of germination after weeks or months. Again: if a virulent liquid was largely diluted, the filaments were destroyed, but the spores survived. In all these cases the activity of the virus disappeared with the death of the organism, and was retained whenever the formation of spores had enabled this to resist the unfavorable conditions.

Here was a proof of the pathogenic character of the schizophyte much more satisfactory than the mere demonstration of its presence in all cases of the disease, or the additional evidence that it might be passed through a certain number of cultivation-flasks; the liquid in the last being as virulent as in the first.

Since Koch's paper was published, Pasteur has added observations of an equally convincing character. The liquid part of the virus may be freed from the organism either by filtering through plaster or by decanting after it has stood in a constant temperature for a few days to allow the germs to gravitate to the bottom of the flask. In either case the liquid is harmless, and the separated germs still produce the disease. Again: compressed oxygen destroys the filaments, but does not affect the spores; and a virus containing only the former loses its activity when treated with this agent, while one in which spores have formed retains its virulence.

We are able to say, therefore, that, in the disease known by the French as charbon and by the English as anthrax, no liquid is virulent unless it contains the living Bacillus anthracis, and that the death of this organism always coincides with the destruction of the virulence.

This demonstration of the pathogenic action of the Bacillus cannot but be regarded as equally satisfactory with what is obtained by investigations in other departments of biological science. If the observations of these gentlemen are accurate, and they have been confirmed too often to be doubted, then there is no escaping the conclusion that the Bacillus anthracis is the essential and only cause of anthrax.

It is not to be denied, however, that the size of the parasite in anthrax, and the fact of its existence under two forms having such unequal resistance to unfavorable conditions, were characters which greatly facilitated the demonstration of its pathogenic relation to the disease. Is it possible to obtain equally satisfactory evidence in regard to the smallest of the schizophytes, and one which only exists in the vegetating condition?

The micrococcus of chicken-cholera is of this kind, and it is consequently very interesting to see just what progress we have made in demonstrating its identity with the virulent principle. We know from Pasteur's investigations that it is always present in this disease; that it may be cultivated, and passed from flask to flask for many times, without losing its virulence. The filtered liquid loses its activity; that from which the germs are separated by gravitation is equally harmless. Taking up the study here, I have proved that the exact degree of heat which, in a given time, kills the micrococcus (132° F. for 15 minutes), destroys the virulence at precisely the same point; also that the proportion of carbolic acid, of sulphuric acid, and of a solution of chlorides (Platt's), which destroys the virulence in from two to four hours, corresponds with the proportion which is required to kill the organism in the same time.

The effect of heat and of these disinfectants on the virus was determined by inoculation experiments. The point at which the micrococcus is killed was learned by placing a drop or two of virus in the sterilized liquid of a cultivation-tube after the proper proportion of disinfectant had been added. In a given time a drop was taken from this tube, and placed in a second one which contained a favorable medium for the growth of the germs. If the schizophytes had been destroyed by the disinfectant, there would be no multiplication; while, if they had resisted it, they would certainly reveal the fact by developing in their usual manner. The exact correspondence which exists between the results of the two series of experiments in every case, is also an evidence of the reliability of the method.

While it might be conceived, that, even though the virulent agent consisted of something entirely different from the micrococcus, both might be destroyed by the same degree of heat in the same time, it is not conceivable that this would also occur from the effect of three different chemical agents. If it were necessary, this line of evidence could probably be increased indefinitely; but it is already equal to what is usually considered necessary to demonstrate a point in other departments of science.

It is possible, then, by present methods of research, to determine satisfactorily whether a given organism is the cause of a certain disease, or whether it is an epi-phenomenon; and, if there is still much doubt in regard to some of these, it would seem to be owing to the fact that observers have relied too implicitly upon the microscope, and neglected the cultivation and inoculation experiments, that are essential to definite and reliable conclusions.

D. E. SALMON.

SPONGE-CULTURE IN FLORIDA.

THE U. S. national museum has lately received from Messrs. McKesson and Robbins, sponge-importers of New York, an interesting contribution representing the first successful attempts at sponge-cultivation on the American coast. It consists of only four specimens, all of the finest or sheep's-wool variety, which were raised from cuttings at Key West, Fla., by the agent of the above-named firm. The localities in which the sponges were planted were not the most favorable for sponge-development, and their growth was therefore less rapid and perfect than might otherwise have been the case. They were fastened to the bottom, in a depth of two feet and a half, by means of wires or sticks running through them, and allowed to remain down a period of about six months before they were taken up. Fully four months elapsed before they recovered from the injury done them in the cutting, which removes the outer 'skin' along the edges of the section; and the actual growth exhibited was for about two months only. The original height of each of the cuttings was about two inches and a half. One was planted in a cove or bight where there was little or no current, and its increase in size was very slight. The other specimens were placed in tide-ways, and have grown to from four to six times their former bulk, which certainly promises well for the future of sponge-propagation. Two hundred and sixteen specimens in all were planted at the same date, and, at the last accounts, those which remained were doing finely.

The chief obstacle to the artificial cultivation of sponges at Key West arises from the fact that the sponge-fishermen infest every part of the region where sponges are likely to grow, and there is no legal protection for the would-be culturist against intruders. The enactment of judicious laws bearing upon this subject by the state of Florida, or the granting of special privileges conferring the right to occupy certain prescribed areas for sponge-propagation, would undoubtedly tend to increase the annual production of this important fishery, which has remained at a standstill for several years past, mainly because of the partial exhaustion of several of the most extensive sponging-areas.

Accompanying these artificial growths was a collection of over a hundred specimens of the various grades of Florida sponges of different sizes, each labelled with its supposed age, based upon estimates of the average rate of growth, by the sponge-collectors. This entire collection now forms a part of the American exhibit at the great London fisheries exhibition.

R. RATHBUN.

THE CONDITIONS NECESSARY FOR THE SENSATION OF LIGHT.

It is generally assumed that the only condition necessary for the production of the sensation of light by the action of radiant energy is, that the radiant energy must be of a certain wave-length within the limits of wave-length of the visible spectrum, namely, between wave-lengths 7.604×10^{-5} centimetres and 3.933×10^{-5} centimetres; that, when the eye perceives nothing, none of these wave-lengths can be present. It is worth while, therefore, to examine those physical conditions that result in giving the sensation of light to ascertain whether such assumption is warranted. As to the eye itself, it will not make any difference so far as this question is concerned, whether one accepts the Young-Helmholtz theory of vision, the Herring theory, or any other. The only important fact is, that, in either, *energy* is required and is expended in the eye; but it is important to know how to measure the energy, and to have a tolerably clear idea about its form. Without any question, a ray of radiant energy, such as is emitted by a heated molecule or atom of hydrogen, consists of a single line of undulations of a definite wave-length, for the molecule cools (that is, loses its heat-energy) by imparting it to the ether; and a 'wave-length' is simply the distance to which such a disturbance in the ether will be propagated during the time of a single vibration of the molecule. As each vibration of the latter imparts some of its energy to the moving ether, it follows that the energy of a ray of light must depend upon the number of vibrations per second; or, what is the same thing, the energy of the ray is proportional to its length. As all rays move with the same velocity in the ether, it follows that any object that should receive such radiant energy would receive an amount proportional to the time.

Suppose, now, that an atom of hydrogen be made to vibrate, no matter how, so as to give a wave-length $C = 6.562 \times 10^{-5}$ centimetres. If such a ray falls upon the eye, it will produce the sensation of redness, and, if the eye receives the vibrations for one second, it will receive 4.577×10^{14} vibrations; that is to say, it will receive as many undulations from the ether as the generating atom made in the interval of one second. Now, we know experimentally that the eye can perceive when the interval is as small as the millionth of a second, when the number of vibrations of such a ray as the above would be 4.577×10^{8}, a very respectable number. It would seem probable that that number might be considerably reduced, and still leave a sufficient number to affect the eye. If the time-interval should be made so short as the one ten-billionth of a second, there would then be 45,770 such undulations that would enter the eye. But there must be a limit to the number needed to produce the sensation; and it is also probable that this limit will differ in different persons. Admitting this time-limit, it follows that undulations of proper wave-length may exist about us, and yet not be sufficient in time-quantity to affect the eye. If other vertebrates or insects possess a shorter limit than man, it is certain that they will see when man cannot. But the energy of vibrations varies as the square of the amplitude; and hence, if one of two rays of equal length has a greater amplitude than the other, the latter might be seen, while the former might not, although they had the same wave-length.

According to the kinetic theory of gases, the molecules are in incessant motion, in which collisions result in changing the directions of the free paths of each of the molecules, and also in making each to vibrate, because molecules are elastic. This vibratory motion proper, being a change of form of the molecule, is what constitutes its heat-energy. The interval between encounters gives opportunity to each molecule to vibrate in its own periodic time or some of its harmonics. Maxwell computed the number of impacts per second for several gases,[1] and gives, for hydrogen, $17,750 \times 10^{6}$. If, then, we divide the number of vibrations per second by the number of impacts, we shall have the number of vibrations between impacts: $\frac{4.577 \times 10^{8}}{177.50 \times 10^{6}} = 25,700.$ This is on the supposition that the vibrations produced are all of the wave-length of the C hydrogen-line.

It is highly probable that this hydrogen-line is not due to the fundamental vibrations of the hydrogen molecule, but that it is some harmonic (the twentieth, according to Stoney). Whatever its harmonic relation may be, it must be highly probable that it will frequently be produced when the conditions are as they are in ordinary gas; but, in normal conditions as to temperature, that gas is not luminous. If this reasoning be right, the reason it is not luminous at ordinary temperatures and pressures is due solely to the slight amplitude of the vibrations of proper wave-length, not to their entire absence. When the gas is heat-

[1] *Nature*, Sept. 25, 1873.

ed, or is impelled with great energy from the terminal of an induction-coil in a Geisler's tube, it is not necessary to assume that the molecules are made to vibrate in wholly new periods, but that the amplitude of their vibrations in any and all periods has been increased, thereby giving greater amplitude, and consequent energy, to the radiant undulations emitted, sufficient to affect the eye.

When one considers the kinetic energy of molecules due to their temperature, it seems probable that all bodies — solid and liquid, as well as gaseous — must be vibrating in all possible periods continuously; but in solid sand in liquids the shortness of the free paths makes interference too frequent to allow any molecule to vibrate many times between impacts, and hence the harmonics suffer most, and are destroyed before they can have given rise to undulations in sufficient number or in amplitude to perform any optical service. By heating a solid, greater amplitude is given to all the vibrations, and we see the red or longer undulations first during the process of heating, because such are less easily destroyed by impact than the shorter ones, which cannot have at best so great an amplitude. This statement assumes that it is with molecules as it is with visible masses of matter: the greater the number of vibrations possible to it, the less the possible amplitude.

With these conditions as stated, it is readily seen why common objects are not at all times visible, that is to say, are not luminous. It is because our eyes are not sensitive enough to respond to the slight energy of the undulations due to both lack of amplitude and shortness of the rays, not because those rays are absolutely wanting. A. E. Dolbear.

RADIOMETERS WITH CURVED VANES.

Among the radiometers in a collection which I have recently examined were two with curved vanes of silver. The radius of curvature was less than 2 cm. When placed in front of a lamp, the concave side moves towards the source of heat. I have found no satisfactory explanation of these movements. According to a recent article by Dr. Pringsheim, the convex side of these vanes is supposed to be at a higher temperature than the concave side. The grounds for such an hypothesis are not obvious; and it would seem hardly possible that an appreciable difference could exist between the surfaces of a thin sheet of silver.

It is more probable that the air on one side of the vane is hotter than that on the other. Since the 'kick' of a molecule depends on its increase in temperature, the vane will move towards the side on which the air is the warmer.

Dr. Pringsheim mentions an experiment in which he brought the heat to a focus inside the radiometer at a point in front of the vane. He found that the air gave no evidence of being heated. I repeated the experiment with solar heat, using a lens of three inches diameter and four inches focal length. The heat in air was sufficient to ignite instantly a common parlor match. When the focus was kept in front of the vane of an ordinary radiometer for two minutes, no appreciable effect was observed: the instant it touched the vanes, however, they gave a start, and began to revolve. This experiment shows that the effects observed with curved vanes cannot be attributed to concentration of heat-rays from the vanes.

According to the kinetic theory, this rotation is set up only if the molecules arriving on the convex side of the vane receive a greater positive increment to their velocity than those arriving on the concave side. These conditions are satisfied in this way: if the vanes are warmer than the air, the particles leaving the vane in both directions have an increased velocity; but take, for instance, the particles moving in lines parallel to the axis of the concavity towards the vane from either side, those on the convex side are scattered by reflection, those on the concave side are brought to a focus at a distance (in this instrument) of less than 1 cm. from the vertex of the concavity. The molecules in the vicinity of this focus receive an increase of kinetic energy; and similar reasoning holds for the sets of molecules moving parallel to each other in any other direction. Hence the molecules on the concave side are hotter than those on the convex side, though not necessarily so hot as the vane itself. Since the molecules on the concave side receive a smaller increase of velocity from the vane, they give it a smaller reactive push.

The action of the case in a radiometer is very prettily shown by wetting it with cold water. The action is best examined with curved vanes, or with vanes of metal covered on one side with mica. The rotation is at first in the same direction as on heating, showing that the air has become cooled by contact with the glass, but is after a time reversed, showing, that, by quasi-conduction through the air, the vanes have become cool, while the glass is regaining its original temperature.

George W. Evans.

THE IGLOO OF THE INNUIT.[1]—II.

AMONG the natives of North Hudson's Bay, the first huts of the season, if there is a scarcity of compact snow, are made of ice. Rectangular slabs, three to four by six or six and one-half feet, are cut from some neighboring fresh-water lake where the ice has formed to a thickness of six inches. As a rough approximation, these slabs may be said to be about the size of an ordinary door. The slabs are placed almost upright, resting on their ends, and joined so as to form a circular pen of from ten to fifteen feet in diameter. Over the top of this the summer seal-skin tent (toó-pik) is spread for a roof; being supported by the tent-poles crossing at convenient places, and held in place by a lashing of seal-skin about a foot below the top of the ice-slabs.

In one of the slabs, generally on the side facing the south, a large opening is cut, which is further protected by a smaller storm-igloo having an entrance-hole no larger than the girth of the most corpulent Innuit of that particular village.

As an aid in cutting, a rectangle is marked on the surface of the ice, having a width equal to the length of the proposed slabs, and from it they are cut with an ice-chisel (toó-oke). This chisel is generally a heavy mortising-chisel, securely lashed to the end of a pole from six to seven feet long. I have seen bayonets, sabre or sword points, or sharpened files made to serve the same purpose. The Esquimaux around King William's Land used the spikes from the wrecked ships of Sir John Franklin's ill-fated expedition. The large ice-slabs weigh nearly half a ton. When dragged from the lake, they are turned on edge, and a hole cut through their centre. By means of a strong seal-skin line passed through this hole, two strong men can handle a slab with considerable ease, moving or sliding it long distances. It takes four or five persons to put the first two together, the slight inclination which is given them holding them up when once in position. After this, two or three are all that are needed to add each slab, until the house is completed. When two slabs are abutted against each other, the edges are trimmed with a snow-knife to give as much bearing-surface as possible; and, when permanently set, snow dipped in water is applied to the joint inside and out, completely closing all crevices, and, when frozen, binding the two as solidly as if but one. A handful is also put in the central hole, which held the seal-skin thong, and the ice-pen is practically air-tight around its sides. The floor of snow has become packed by the treading of the builders; and over it are laid flat stones, on which are spread a great many coarse robes of reindeer, musk-ox, and polar-bear skins, and over these the finer reindeer-skins that make the bed, which occupies over half the floor.

MAKING AN ICE-IGLOO.

These ice-igloos are as transparent as glass; and before they are covered by the drifting snow, or their interiors dimmed by the smoking of the sooty lamps, a night-scene in one of these villages, especially if it be large, with the brilliant burning stone lamps in full blaze, is one of the most beautiful sights I have ever witnessed, especially in this dreary land. Could one imagine the little Lilliputs living in flat candy-jars with drumhead covers, he would

[1] Continued from No. 28.

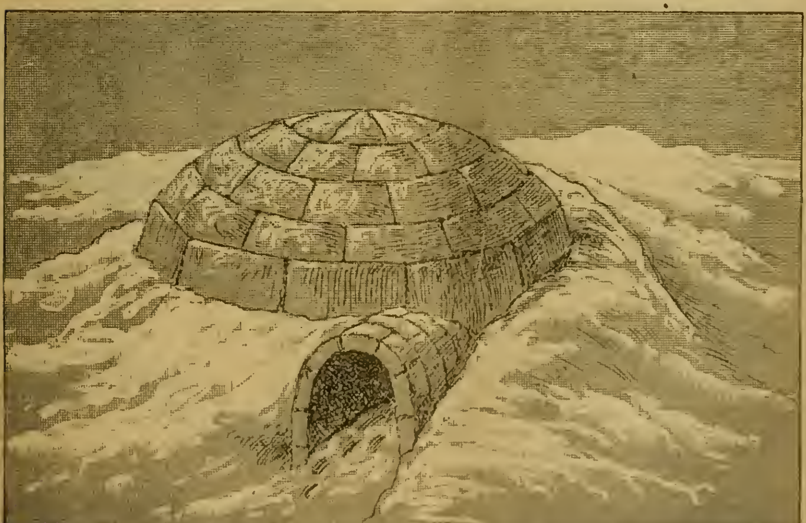
have a fair miniature representation of an ice-village.

Our canvas tent becoming very uncomfortable on account of the intense cold, which had sunk to nearly — 30° F., we had a large ice-igloo constructed, into which we moved on the 1st of November. 1878. and found it decidedly more habitable.

If the village be small, they generally construct an ice-house per day, all working, either cutting out the slabs, hauling them to the igloo site, putting them into shape, or chinking the cracks with wet snow; and this is continued until all are housed. If a large village, they divide into parties.

Sometimes the Innuits will retain their ice-igloo, even after the snow has become fit for building-purposes, the seal-skin tent being removed, and a new dome-shaped roof made of snow-blocks. Such cases, however. are extremely rare; and unless this combination igloo is covered in thoroughly with deep snow-drifts, or with snow thrown upon it to a depth of at least four to six feet, it will not compare in comfort with that of snow alone. The relative conductivity of the two materials, snow and ice, readily explains the reason. The ice also condenses the moisture of the breath, and the steam from cooking, more readily upon its cold, smooth surface; and this becomes at last an almost unbearable annoyance. — an annoyance which can be comprehended without explanation. The advantage of this igloo of ice is in its straight upright walls, which give more room than the slanting sides of the snow-house, while it is also easier to build, the ice portion being already constructed. We lived in such an igloo during the winter of 1878–79; but none of the Innuits around us retained theirs, and often complained of the cold when in ours, and referred it to its peculiar construction. I might add. however, that our three bedrooms or bed-igloos. which were attached to and communicated with the main one of ice, were wholly of snow.

As the reader must have already surmised from the hints given from time to time, the true igloo is built of snow, those already described being used but a very small portion of the year. It is used on all their winter journeys, even for a single night: and, as contrary to the prevailing belief, the Innuits travel the most during this season, one can see that a person sharing their life and travels would have many opportunities, during two long winters with them, to see igloo-building and igloo-life in nearly all its aspects.



AN ICE-IGLOO WITH SNOW CAPPING.

When the native has decided to relinquish his house of ice for one of snow, or on a sledge-journey has decided to go into camp,—in short, is going to build an igloo, — the first thing done is to get out the 'snow-testers,' with which they determine the compactness, depth, and general availability for building-purposes of the snow-drifts. The ancient style of snow-tester, *a*, and

SNOW-TESTERS, ANCIENT AND MODERN.

those yet used by the Esquimaux who have no trading communications with the whalers and explorers, is one made from reindeer-horn, about the diameter of a little finger, and probably three feet long. One end is sharpened, and the other, formed as a button about the size of a quarter of a dollar, is held in the palm of the hand. The modern tester, *b*, is simply the iron rod of the seal-spear with the barb removed.

Having halted on some lake that they know by certain signs has not yet frozen to the bottom,[1] the men scatter out like skirmishers along the deep snow-drifts near the shore, and commence prodding with their testers. Finally a shout from one shows that he has been successful; and, leaving the tester sticking in the snow to mark the spot, he and the others return to the sledges, which are then brought up, and the building commences.

It takes considerable experience, coupled with good judgment, to pick out the best building-site; and, while the constant prodding with the testers oftentimes looks foolish to a spectator, it is no inconsiderable part of the performance. Snow which looks perfect on the crust may be friable beyond use a few inches deeper, and this the tester will reveal. Soft drifting snow may cover a bank of splendid building-material. Again, the drift may be freely interspersed with hidden stones and bowlders, which the testers will bring to light if freely used. This testing for good snow generally occupies from ten minutes to a quarter of an hour: but I have seen it drawn out to an hour, or so long as it takes to build the igloo itself; and, in fact, I have seen them compelled to abandon the most favorable looking lake after having skirted its whole outline, and move on to the next.

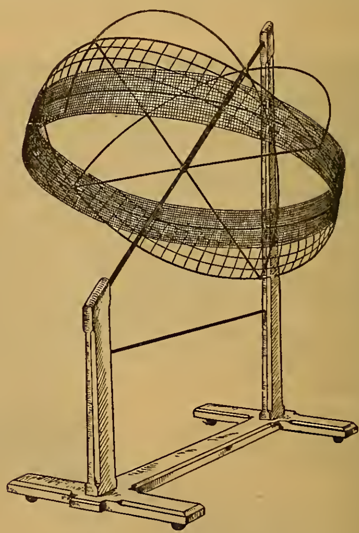
[1] This is generally done by lying flat on the ice, and placing their eyes as close to it as the nose will allow, when some varying peculiarities of the ice-colors decide their conjectures.

(*To be continued.*)

ILLUSTRATIVE APPARATUS FOR ASTRONOMY.

THE accompanying figure represents an apparatus designed for use in teaching astronomy. It is mounted so that the axis on which it rotates is parallel to the earth's axis. Two circles represent the equinoctial and ecliptic, and on the latter is a strip of wire cloth to represent the zodiac. The circles are of such a size that the meshes of the cloth (in this case a half-inch) are one degree in size, and larger meshes of five degrees are made, extending to the circle of the equinoctial. The northern halves of the two colures help to hold all in position. The lower part of these latter circles are dispensed with, so that one may conveniently stand near the centre, the frame being of such a height as to bring the centre nearly on a level with the eye.

It helps the beginner to obtain a clear conception of the fundamental circles so often referred to, of their actual position in the



heavens, and their apparent diurnal change of motion. It enables him also to represent the sun, moon, and planets in their correct positions at any time, their right ascensions and declinations (or longitudes and latitudes) being given. For this purpose I use disks of cardboard, with small hooks attached by which they may be readily fastened to the wires. It is, besides, very convenient to use in the explanation of many questions and topics that arise in the course of the subject. A light rod or wire attached to a standard serves as a horizon when required.

The apparatus grew out of the need felt of something besides the celestial globe and the usual means of illustration for use in the lecture-room. The idea of it was suggested by a description of something like it which some one had seen; but the description was so vague, I am unable to say how nearly similar is this design, or whether it is any improvement or not on what may be used elsewhere. But I have found it to serve a very good purpose in the lecture-room, and think it may be serviceable to other teachers. G. B. Merriman.

HELL'S OBSERVATIONS OF THE TRANSIT OF VENUS IN 1769.

Professor Newcomb has lately taken advantage of a visit to the Imperial observatory of Vienna to make, with the consent and support of its director, Prof. E. Weiss, an examination of Father Hell's manuscript record, with reference to deciding on the alleged falsification of these observations by Hell himself. The result of his examination was so different from that generally accepted, that Professor Newcomb prepared and presented to the Royal astronomical society a statement of the evidence and his conclusions. The story of Hell's supposed tampering with his observations of the transit, made at Wardhus in 1769, is, in substance, that he delayed publishing them so long as to give rise to the suspicion of intending to alter them; that he showed them to no one until after he had received the observations made at other stations; that a cloud was thus thrown over their genuineness; that the suspicions thus excited were confirmed in 1835 through the discovery and publication by Littrow of Hell's original manuscript journal, which its author had neglected to destroy; and that the examination of this journal showed numerous cases of alteration and erasure of the original observed figures, including the seconds of first interior contact, which had been completely erased, and replaced by new numbers inserted with different ink at some subsequent time. And the reason for all this was supposed to be, that Hell desired to publish, not his true observations, but results which should be in the best possible accordance with the observations of others. More precise statements on some points are these: the transit occurred 1769, June 3; Hell's party sailed from Wardhus, June 27, but meeting with delays from adverse weather, and stopping to make observations, they did not reach Drontheim until Aug. 30; after some stay here and in Christiania, Copenhagen was reached on Sept. 17; the observations were communicated to the Danish academy of sciences in November or December; the printing commenced Dec. 13, and on Jan. 13, 1770, Hell received twenty printed copies. Professor Newcomb remarks that he does not know the original authority for the statement that Hell was loudly called upon for his observations before he would consent to their publication.

The document which Professor Newcomb has scrutinized is a thin manuscript volume in folio, containing twenty-seven finely written pages, and nearly as many blank ones, bearing the heading "Observationes Astronomicae et Caetera in Itinere litterario Viennâ Wardöehusium factae. 1768. A. M. Hell." This volume is assumed to be in Hell's own writing, and to be his original journal of his observations. Littrow apparently treats of it as the actual first record of the observations, but to Professor Newcomb this seems very improbable. He concludes that the writing of this journal was done at the observing-station, probably at the close of each day's work or each set of observations. What Hell sent to press in December, 1769, was not a transcript of this journal, but a more copious account, containing eighty-one printed pages, with only an occasional identity of language. But, with a single unimportant exception, the numbers are all printed without change from the original manuscript journal, whether corrected or uncorrected in that journal. It is very clear to Professor Newcomb that nearly all the alterations were made at the station — two, at least, before the ink got dry. And he further concludes, that, *whatever the sources from which the corrections were derived, the numbers as printed by Hell were all but one or two obtained at Wardhus.* Going into these manuscript corrections more in detail, it seems quite clear to Professor Newcomb that the alterations in the numbers representing the observations of first contact were made with the same ink as the original; and he regards only one conclusion as certain, — that the corrections were made at the time of writing, and without the slightest intention of giving any thing but the actually observed moment when Venus was first seen.

Coming now to the much disputed observations of internal contact, the figures of seconds seem at first sight to be corrected. Littrow says that the paper bears marks of having been scraped, and that the original figures of seconds had been carefully erased, the ink, in consequence, spreading in the paper. Professor Newcomb remarks, that one sees at a glance that the latter statement is erroneous; and he applies to the question of erasure the test of viewing the paper by oblique sunlight, and proves the texture of the surface to be still uninjured. The evidence thus leads to the certain conclusion, that no different figures from those now visible were ever written there. If, then, they are in any way the result of calculation from other observations, the place must have been left blank until Hell got back to Copenhagen, and made the necessary calculations, — an hypothesis too fanciful for serious discussion. Another part of the record looks more suspicious, — a line, 'fulmen 9 32 48,' is not only an interlineation, but is written in decidedly different ink from all the original manuscript. The original journal, up to the time that Hell left Wardhus, being all written in one kind of ink, we conclude that the insertion was made after he reached Copenhagen, and after he had seen the observations of others. Two hypotheses are before us as to how the insertion was determined, — we may suppose that Hell, when he found he had omitted what other observers considered an important phase, tried to remember how long after the recorded contact he first saw the sun's limb continuous, and wrote the result in his journal; or we may suppose that he made a memorandum at the time of the observation, but omitted to copy it in the journal, either through inadvertence, or because he deemed it too late for contact. When he found the phase important, he merely copied the omitted record in his journal. The use of the queer word 'fulmen,' which appears only in the manuscript, seems to Professor Newcomb to give color to the latter hypothesis. He can hardly conceive of one using it deliberately, after six months, to express the formation of the thread of light; whereas, at the moment of observation, in the excitement and hurry, it would be a very natural single word to designate the rapid increase of the effulgence of solar light around the following limb of Venus, which follows true contact at ingress. It is a strong confirmation of this view, that Mr. Stone, without apparently having made any comparison with Hell's printed observations, reached this same conclusion as to the probable use of the word 'fulmen.'

With regard to the egress of the planet, the times of Hell's notes of the 'gutta nigra' are each increased by two seconds; but obviously this correction was made at the time of writing. More serious is a correction of the time of observation by Sajnovics, the companion and assistant of Hell. They, no doubt, discussed their times; and, in consequence of such discussion, Sajnovics concluded that his times were late. In the exterior contacts, the only corrections are such as were made at the time of writing, and to which Professor Newcomb attaches no importance.

Regarding certain collateral circumstances which have been supposed to cast suspicion upon Hell's intentions, not only does Professor Newcomb see no suspicious delay in making known his observations (for the whole paper, containing an account of his instruments, observations, and results, including an investigation of his quadrant and clocks, a discussion of his latitude, longitude, and time, and a full statement of his observations, was written, printed, and ready for distribution, four months after his return to Copenhagen), but it seems difficult for him to suppose that Hell could have had time to make so complete a reduction of the observations of others as to be able to compare them with his own. That his observed times of the contacts were not published in advance, as were those of many other observers, but appeared first in an official form under the imprint of the Academy of sciences, seems to Professor Newcomb in accord with very proper feeling, as the observations were made under the auspices of the king of Denmark, and dedicated to him; and furthermore, owing to the position of the station being unknown, publication in advance could have served no useful purpose.

In his discussion, Professor Newcomb makes but slight allusion to the absence of many circumstances which might be expected to accompany manufactured observations; but he has presented all the positive evidence within reach so fully as to enable every one to draw his own independent conclusions. His own conclusions are, —

First, The belief that there was any suspicious delay in the publication of Hell's observations, or any thing in his course to give reasonable ground for a suspicion that he intended to tamper with his observations, is a pure myth.

Second, Excepting the time of formation of the thread of light at ingress; excepting, also, a discrepancy of one second in the time of internal contact, and a change of two seconds in one of Sajnovics's times, — it is proved, not only negatively and presumptively, but by positive evidence and beyond serious doubt, that all the essential numbers of observation given by Hell, whether relating to the transit, time, or longitude, are printed as concluded upon and written in his journal at Wardhus, before there was any possibility of communication with other observers.

Third, The addition of the time of the formation of the thread of light was suggested by the accounts of other observers; but the time itself is Hell's own, obtained possibly from estimation and memory, but more probably from a memorandum made at the time of observation, which he neglected to insert in his journal.

Fourth, The alterations in Sajnovics's time of second internal contact were probably made, because Sajnovics himself afterward concluded that his recorded time was too late; but it may be assumed, that, in reaching this conclusion, he was influenced by Hell's observations.

Professor Newcomb adds, respecting his own proceedings in investigating this subject, that, in commencing the examination of Hell's journal, he had no hope of doing more than deciding whether it was or was not safe to use Hell's numbers as actual results of observations, and no thought of doubting the commonly received view of the case. He soon became perplexed to find himself differing entirely from the conclusions of Littrow. Before the latter had found the manuscript, suspicion had rested upon Hell's truthfulness; so that when he looked into the manuscript, and saw such extensive alterations, the indictment seemed so clearly proven that Littrow's only duty was to make the facts which proved it known to the world. He thus unconsciously assumed the tone of a public prosecutor, and saw all the circumstances from an accuser's point of view.

LETTERS TO THE EDITOR.

Errata in catalogues of stars.

The Washburn observatory possesses a nearly complete collection of such star-catalogues as have been printed since the year 1800. A list of them is given below. It will be noticed that this list does not include the very expensive British association catalogue. Oeltzen's Argelander's Northern zones is also missing from the list, as I have been unable to buy it in Europe during the past two years. Another very scarce catalogue (Weisse's Bessel's Zones from + 15° to − 15°) I have just obtained after two years' delay.

In each one of these catalogues, I have had every erratum known to me inserted in its proper place, so that the set of catalogues really represents what is known, freed from an enormous mass of misprints and real errors.

I am not able to say how many material errors have been corrected, but certainly not less than twelve thousand. I think those who use star-catalogues most will be most surprised at the amazing number of material errors which still remain in the catalogues which they employ daily.

I have called attention to these errors in order to say that I will engage to have any of the catalogues of the following list corrected completely, in all respects like my own, for any observatory, or for any astronomer who may desire it.

The catalogue should be sent by American express, prepaid, addressed to me, and accompanied by a note asking that the work be done. The book, when corrected, will be returned by express at the owner's expense.

The corrections will be made by one of my assistants, under my direction, and an account kept of the number of hours spent on the work. The work will be charged for at the rate of fifty cents per hour. I may say that the sum so received will be paid to the copyist.

It has appeared to me, that, after the large amount of labor which has been expended on my own catalogues, I was under obligations to give the benefit of such work to others, and this I willingly do.

The first list following gives the names of the catalogues owned by the Washburn observatory; the second gives the sources from which the errata have been derived. I shall be much indebted for references to errata not there mentioned.

EDWARD S. HOLDEN.

Washburn Observatory, Madison, Wis.,
Aug. 1, 1883.

I. List of star-catalogues.

Airy: Catalogue of 1,439 stars. 1840.0.
—— " " 1,576 " 1850.0 (6-year).
—— " " 2,022 " 1860.0 (7 ").
—— " " 2,760 " 1864.0 (7 ").
—— " " 2,263 " 1872.0 (9 ").
Argelander: Bonn observations, vols. 1-7. [Vols. 1 and 2 not corrected.]
—— Uranometria nova. [The maps not corrected.]
Baily's Lalande.
Behrmann: Uranometry. [The maps not corrected.]
Brisbane: Paramatta catalogue.
Carrington: 3,735 circumpolar stars.
Gould: Uranometria argentina.
—— D'Agelet's Catalogue.
Heis: Atlas coelestis. [The maps not corrected.]
Johnson: First Radcliffe catalogue.
Lamont: Catalogues, 6 vols.
Main: Second Radcliffe catalogue.
Robinson: Armagh catalogue.
Rümker: 12,000 stars.
Schjellerup: 10,000 stars.
Stone: Cape catalogue. 1873.
—— " " 1878.
—— " " 1880.
Weisse's Bessel's Zones I. and II.
White: Melbourne general catalogue. 1870.

II. List of sources where errata are found.

⁂ The name of the author of the catalogue comes first, then a brief reference to the particular catalogue, and, last, a reference to the place where the errata are given. No reference is made here to corrections which are usually bound in the same covers with the original catalogue, or which are given in subsequent volumes of the same work. I have also included here a few reviews which contain no errata, properly speaking.

Airy: New 7-year catalogue. — V. J. S. 1871, 100.
Argelander: Bonn obs., vi. — V. J. S. 1867, 272.
—— Durchmusterung. [A single correction to D. M.] — Astr. nachr., lxxi. col. 240.
—— - [Places of two stars not in D. M.] — Astr. nachr., lxxii. col. 55.
—— - Astr. nachr., no. 1765.
—— - Astr. nachr., no. 2396, col. 305; no. 2429, col. 69.
—— - [Ueber einen in der D. M. fehlenden stern.] — Astr. nachr., no. 2459.
—— - Astr. nachr., no. 2478. Same, no. 2527.
—— Uranometria nova. — Astr. nachr., xxvi. col. 318.
—— - Annals Harv. coll. obs., ix.
—— Northern zones. — Bonn obs., v.
—— - [Fortsetzung von band v.] — Bonn obs., vi.
—— - [Theoretical; with a few corrections to the zones.] — V. J. S. vol. 8, 221.
—— Southern zones. — Bonn obs., vi.; Cooper's Ecliptic stars, iv.
Baily's Lacaille: Catalogue. — Bonn obs., vii. 245; Cape catalogue. 1880.
Baily's Lalande: Catalogue. — Bonn obs., vii. 213 seq; Schjellerup, 10,000 stars, p. 225.
Behrmann: Atlas des südlichen gestirnten Himmels. — V. J. S. 1875, 89.
Bessel: Zones. — Bonn obs., iv. p. i.; v. p. xxxii.
British association catalogue. — Cape catalogue, 1840; same, 1880.
Brisbane: 7,385 stars. — Cape catalogue, 1840; same, 1880.
Cape catalogue: 1840. — Stone, Cape catalogue, 1880, 559. [A single correction.]
Catalogues: Errata in standard catalogues of stars. — Monthly not. R. A. S., viii. 161. [This volume I have not access to at present.]
Copeland & Börgen: Mittlere oerter sterne zwischen 0° und −1°. — V. J. S. 1870, 197.
D'Arrest: Siderum neb. obs. hav. — V. J. S. 1868, 94.
Dreyer: Supplement to Herschel's General catalogue. — V. J. S. 1878, 274.
Ellery: First Melbourne catalogue. — V. J. S. 1876, 178; Monthly not. R. A. S., xlii. 308.
Fedorenko: Catalogue. — Bonn obs., vi.
Gilliss: Catalogue U. S. naval astron. expedition. — V. J. S. 1872, 46.
Gould: Reduction of D'Agelet. — V. J. S. 1867, 2.
—— Standard places of fund. stars. — V. J. S. 1867, 22.
—— Uranometria argentina. — Cordoba observations, ii. 295.

Groombridge: Catalogue. — In First Radcliffe catalogue.
—— - Bonn obs., vi.
Heis: Atlas coelestis. — Annals Harv. coll. obs., ix.
—— - V. J. S. viii. 67, 278; ix. 236; xiii. 111.
Herschel: Gen. cat. nebulae and clusters. — V. J. S. 1866, 176.
—— Catalogue of 10,300 double stars. — V. J. S. 1876. 61.
Johnson: First Radcliffe catalogue. — Bonn obs., vi.
Lacaille: Coelum australe stelliferum. — Bonn obs., vii.
Lalande: Catalogue. — Monthly not. R. A. S., xiv. 195. [This volume I have not access to at present.]
—— Histoire céleste. — Bonn obs., vii.
—— Observations of 1789–90. — Bonn obs., vi.
—— Catalogue. — Cooper's Ecliptic stars, iv.
Lamont: Catalogues (6 vols.) — V. J. S. ix. 94.
Main, R.: 2d Radcliffe catalogue. — V. J. S. 1870, 292.
Newcomb, S.: On the R. Asc. of the eq. fund. stars. — V. J. S. 1876, 158.
—— Catalogue of 1,098 stars. — V. J. S. 1882, 259.
Piazzi: Positiones mediae, 1814. — Bonn obs., vi.
Rümker: 12,000 stars. — Bonn obs., vi.
—— - Cooper's Ecliptic stars, iv.
—— Neuer folge. — Bonn obs., vi.
—— Preliminary catalogue of southern stars. — Stone, Cape catalogue, 1880.
Santini: First two catalogues. — Bonn obs., vi.
—— Posizioni medie di 1,425 stelle. — V. J. S. 1872, 13.
Schjellerup: Al-Sufi's Uranometry. — Monthly not. R. A. S., xliii. 266.
—— 10,000 stars. — Bonn obs., vi.
Schönfeld, E.: Catalog von veränderlichen sternen. — V. J. S. 1866, 113.
—— Zweiter catalog von veränderlichen sternen. — V. J. S. 1875, 73.
Stone, E. J.: Results of astronomical observations at Cape of Good Hope, 1856–58. — V. J. S. 1875, 192.
—— Cape catalogue, 1880. — V. J. S. 1880, 297.
Strasser: Mittlere oerter von fixsternen. — V. J. S. 1878, 88.
Struve (W.): Positiones mediae. — Bonn obs., vi.
—— - Schjellerup's 10,000 stars, p. 225.
Taylor: Madras catalogue. — Bonn obs., vi.; Cape catalogue, 1840; same, 1880.
—— Astron. obs. at Madras, 1843–47. — V. J. S. 1873, 180.
Vogel, H. C.: Positionsbestimmungen von nebelflecken, etc. — V. J. S. 1876, 276.
Weisse's Bessel's Zones, +15° to —15°. — Cooper's Ecliptic stars, iv.
—— - Gould's Astronomical journal, iii. 115. [This contains all the errata of the Astr. nachr. up to 1853, June.]
—— - Annals Harv. coll. observatory, i., pt. ii., p. lviii.
—— - Schjellerup's 10,000 stars, p. 225.
—— - Weisse's Bessel's Zones, + 15° to + 45°, p. xlv.
—— "Catalogue." — Monthly not. R. A. S., xiv. 195. [This volume I have not access to at present.]
Wilson & Seabroke: Catalogue of measures of double stars. — V. J. S. 1877, 108.
Yarnall: Catalogue U. S. naval obs. — V. J. S. 1880, 20.

The search for Crevaux.

Apropos of your recent weekly summary of the progress of geography under the titles of the Death of Crevaux, etc., I may say that a member of the French geographical society, M. Thouars, accompanied the U. S. solar eclipse expedition from Panama to Callao, March 12–21, of this year. M. Thouars had familiarized himself with explorations in South America by extensive travels in Columbia and elsewhere, and intended to penetrate the Pilcomayo region, in search of the relics of the Crevaux expedition, alone, or with only one companion, the two disguised as Catholic priests. The attempt seems foolhardy; and, for my part, I am glad to know that M. Thouars intends to carry a revolver under his priest's robe, and that he is a brave man and an excellent shot.

If he has not abandoned his daring project, we should hear of him during the early part of 1884.

EDWARD S. HOLDEN.

Madison, Aug. 6, 1883.

Occurrence of the swallow-tailed hawk in New Jersey.

Early in the evening of July 28 I was standing on the brow of the bluff overlooking the Delaware River, near Bordentown, N.J., when my attention was called to a large bird sailing in comparatively small circles high overhead. Fortunately there was a dark blue-black cloud behind it, so that I had an excellent opportunity to observe the bird. It was the swallow-tailed hawk (Nauclerus forficatus). It remained in nearly the same position for over an hour, when it altered its flight, and, with steady wing-strokes, flew rapidly in a north-west direction.

The appearance of this hawk here is one of the rarest events in the experience of New Jersey ornithologists. CHAS. C. ABBOTT, M.D.

A reckless flier.

ONE might think a tragic end would await such birds as the Swifts, so bold and persistent their flight; and doubtless such is in store for many, though they seem to steer clear of most obstacles.

A case in point came recently to hand, — that of an unfortunate bird impaled to the spear-point of a lightning-rod above a chimney. There it remained until shot off with a gun, — a warning and a ghastly one, indeed, to all this *swift* race. F. H. HERRICK.

Swallows in Boston.

I saw on the 4th of this month the first swallow in Boston, at the extreme end of City Point, South Boston. I have been on the lookout for them since April. Two friends, good observers, report that they have not seen one this season.

CARL REDDOTS.

Boston, Aug. 7, 1883.

'HAS any one seen a swallow this summer in Boston?' inquires a correspondent in SCIENCE, Aug. 3. Yes: I saw six last week, perched on the state-house. Prior to this I had also raised the query. Whether it was the pugnacious sparrows, or legislature, that had banished these aerial visitors from the capitol, their old haunt, was and is a query.

LEANDER WETHERELL.

Boston, Aug. 11.

WARD'S DYNAMIC SOCIOLOGY.

IV.

IT is Mr. Ward's theory, that the more complex sciences should be based upon the less complex. This he avowedly derives from

Comte, but himself defends at length; and his work is constructed consistently therewith. The part which relates to sociology, therefore, is based upon principles derived from the physical and biologic sciences and psychology, which he treats as a biologic science. Some general mention is made of languages, arts, and opinions, in various portions of the book; but no systematic treatment of these subjects is presented. The same is true with respect to all that body of facts which, if systematized, the author would call static sociology. He only attempts to treat, at length and in order, the forces of society. This theory is but a half-truth, and the method of treatment resulting therefrom has sometimes led to conclusions that are erroneous. The most important failure in this respect is Mr. Ward's presentation of what he denominates the four stages of society: viz., "(1) the solitary or antarchic stage; (2) the constrained aggregate or anarchic stage; (3) the national or politarchic stage; and (4) the cosmopolitan or pantarchic stage." The first or solitary stage is that which Mr. Ward supposes to exist among animals. In the second stage he supposes mankind to have multiplied in great numbers, to have been widely spread throughout the earth, and to have been aggregated without organization. The third stage is represented by the organized tribes and nations of the earth. The fourth stage is a prophecy, when all men shall be organized in one body politic.

It will be well to compare this scheme with that of Morgan in his 'Ancient society.' Morgan attempts to establish what he denominates ethical periods. The three grand periods are savagery, barbarism, and civilization; and savagery and barbarism are subdivided. The following is his scheme: —

I. Lower status of savagery . . .	From the infancy of the human race to the commencement of the next period.
II. Middle status of savagery . .	From the acquisition of a fish subsistence and a knowledge of the use of fire to the commencement of the next period.
III. Upper status of savagery . . .	From the invention of the bow and arrow to the commencement of the next period.
IV. Lower status of barbarism . .	From the invention of the art of pottery to the commencement of the next period.
V. Middle status of barbarism . .	From the domestication of animals on the eastern hemisphere, and in the western from the cultivation of maize and plants by irrigation, with the use of adobe-brick and stone, to the commencement of the next period.
VI. Upper status of barbarism . .	From the invention of the process of smelting iron ore, with the use of iron tools, to the commencement of the next period.
VII. Status of civilization	From the invention of a phonetic alphabet, with the use of writing, to the present time.

It will be seen, that Ward's scheme is consistent with his philosophy, and based on method of aggregation, while Morgan's scheme is based on the development of arts. Ward is right in his philosophic plan, but altogether wrong in its execution: Morgan is wrong in his plan, or method, but more nearly right in his final conclusions; for the three grand stages which he endeavors to establish can with some modification be fully based on the method of aggregation, i.e., on the data of sociology as distinguished from technology. This will be briefly set forth.

The inception of social organization is in the biologic differentiation of the sexes, giving husband and wife, parent and child, brother and sister, and other relations of affinity and consanguinity. At that time, when the species now known as man had made no farther progress than have some of the lower animals at the present time, this elementary organization existed; and a greater or less development of this organization is discovered among many species of the lower animals. On it the subsequent organization was built. The importance of this fundamental organization seems to have escaped Mr. Ward.

Archeologic evidence is now abundant to show, that man was widely scattered throughout the earth at a very early stage in the development of art, i.e., in the paleolithic age. Again: there is abundant linguistic evidence to show, that man was widely scattered throughout the earth at the inception or beginning of the development of articulate, i.e., organized, speech. In this condition he must have had at least something of the social organization which is based on sex. The stories which have been told, to which Mr. Ward refers without giving full credence, of men living in utterly discrete conditions, are but idle tales, and have no place in the data of scientific anthropology. Mr. Ward says, "The second stage embodies none of the elements of permanency, and cannot be expected to be found extensively prevailing at any age of the world. It is essentially a transition stage, and, like transition forms in biology, is characterized by an ephemeral duration. Nevertheless, it has numerous living representatives among the lower existing tribes, particularly among the Fuegians, interior Australians, Wood-Veddas, and Bushmen." The illustrations given of this second stage are also idle tales. These people must also have had the organization mentioned above as based on sex; and it is now known that some of them at least, especially the Australians, have a highly organized system of social aggregation based on kinship. These people are, in fact, organized as tribes. In the presence of facts, the first and second periods of Mr. Ward disappear.

Travellers among savage peoples, seeking for the institutions with which they were themselves acquainted among civilized men, have found them not, and have sometimes reported the peoples to be without institutions, and at other times have completely misinterpreted what they did discover. If we accept such statements, we must believe that some tribes were without organization, and some had the institutions and governments of civilization. And if we compare the statements of a number of travellers about the same people, we shall discover that most of the savage tribes of the earth have been reported, now as being destitute of government and sociologic institutions, and now as having kings, aristocracies, and the elaborate paraphernalia of civilized governments. None of these accounts are true: all are to be rejected. But there yet remains a body of sociologic data relating to the lower tribes of mankind, collected by scientific anthropologists, chiefly during the last two or three decades. We owe much of this knowledge to Morgan's researches, and the investigations of others which have grown out of his suggestions. We now know something of the organization of almost every tribe on the face of the earth, though in many cases our knowledge is exceedingly meagre and fragmentary. Yet perhaps enough is known to warrant the assertion, that there is no tribe so low but that it has a sociologic organization highly developed in comparison with that mentioned above as based on sex and exhibited among the lower animals. The outlines of this plan of organization must be set forth.

The tribes of mankind, as distinguished from nations, have each an organization based on kinship. This system of kinship invariably recognizes grades, based primarily on degrees of affinity and consanguinity, and secondarily on relative age, or the series of generations which may be extant among a people at any given time. All of the relations which exist among such a people, and which may be denominated as rights and duties, are determined by the kinship relations recognized in their social organization, and expressed in their language. This subject is too vast for thorough exposition here, and a single illustration must suffice. Among all such tribes age gives authority, but no method of determining the absolute age of any individual exists among them. Dates of birth are soon forgotten. But there is in the language of every such tribe a device by which relative age is invariably expressed; for every man, woman, and child accosts and designates every other man, woman, and child within the tribe by a term which in itself expresses relative age. Thus, in these languages there is no term for *brother;* but there is one term for *elder brother*, and another for *younger brother*. A man cannot speak of his 'brother' as such simply: he must use a term which says 'my elder brother,' or 'my younger brother,' as the case may be. In the same manner, if he speaks to or of any other person in the tribe, the term by which that person is designated will itself show the relative ages of the persons speaking and spoken to or of. Age gives authority, and this authority is so important and so universal that it is woven into the texture of every tribal language. Every tribe is organized as a great family, — a system of kindred.

From this plan of early tribal organization, there is a great development exhibited in many ways; for tribes are differentiated into classes, or clans, or gentes, which are interdependent bodies politic.

This tribal organization, so briefly characterized, has its fundamental idea in kinship; and the minds of the people in this stage can conceive of no other form of organization. If two or more tribes form an alliance, temporary or permanent, for defensive or offensive purposes, one or both, the same thought prevails. In a council for such an alliance, one of the first propositions to be settled is, 'What shall be the kinship relations existing between us?' and, before the alliance can be consummated, this must be settled.

Once upon a time the Cherokees, Choctaws, Chickasaws, Muskokees, and other tribes met in council for the purpose of forming an alliance against the upper Mississippi tribes of the Dakota stock; and it was decided, that, as the Cherokees lived at the sources of the streams that watered the country occupied by the other tribes, they, the Cherokees, should be called 'elder brothers,' and the tribes living on the lower courses of the streams should come in order from east to west as second, third, fourth, fifth, and sixth born sons, because such was the course of the sun as it travelled over their lands. Then the people of one tribe called the people of another 'elder' or 'younger' brothers, and took precedence and authority in council and war therefrom.

This plan of organization is a distinct method of aggregation, designated as kinship, or tribal; but it gradually developed into something else. As tribes, by alliance, by conquest, and various other processes, enlarged, it was done by establishing artificial kinship, — by what Sir Henry Maine denominates a 'legal fiction;' and in many cases it came to be that the whole organization was chiefly a legal fiction. Kinship ties were chiefly artificial. Under these circumstances the kinship bond, composed of marriage-ties and streams of kindred blood, was found to be but a rope of sand; and gradually, by many steps, the basis of aggregation was changed to territory, and the bonds of society became the organs of government for the regulation of relations arising from property. But, before a territorial system of aggregation is fully established, intermediate stages are discovered. First, the tribal organization occupies a distinct territory, but the territorial organization is latent; then aggregations partly by territory and partly by kinship supervene; and finally, by many steps, kinship organization is abandoned, and territorial organization remains. This gives two very distinct methods of aggregation or plans of social organization, viz., kinship and territorial society, or tribal and national government; and the two are objectively discovered, and not simply theoretical. The first in its simplest state is Morgan's Status of savagery; the second in its simplest state is Morgan's Status of civilization. His Status of barbarism includes the higher forms of kinship organization and the transition forms mentioned above. If we confine his Status of barbarism to the transition forms, we will then have savagery, barbarism, and civilization established properly on modes of aggregation; but barbarism will merely be a transition stage, and comparatively ephemeral.

Of Mr. Ward's fourth stage, it is simply necessary to say that he himself recognizes it as an ideal of the future; but it is properly based upon history, and is in the manifest course of social evolution. Of the myriads of languages once existing, and of many of which we now have but mere glimpses, few remain, and of these few a very small number are rapidly predominating. The many have become few, and the few will be completely unified, for such is the course of philologic evolution. Of the myriads of tribes scattered by the shores of the seas, on the margins of the lakes, and along the streams of all the habitable earth, but few remain. They have been gradually integrated into larger tribes, and finally, with the most advanced, into nations; and the time will come when there will be but one body politic, for such is the course of sociologic evolution. Every tribe of the myriads that have spoken distinct languages has each for itself developed a mythologic philosophy. These mythologic philosophies are rapidly disappearing, and now are comparatively but few; and the time will come when but one philosophy will remain, — the philosophy of science, the truth, — for such is the course of philosophic evolution. The fourth stage of society — the cosmopolitan or pantarchic — is a legitimate induction, a qualitative but not a quantitative prophecy, for who shall say when it shall come?

Morgan's method of basing his stages upon the arts is unphilosophic: it was simply stages of art development, not stages of social organization. But, because art and society have evolved interdependently together, it very nearly represents the truth; but the actual condition of the progress of any given society or body politic can be determined with less accuracy from its arts than from any other department of anthropology, and this from the fact that art is expressed in material form that can be easily imitated. Its use is at once apparent; and a people may easily borrow an art, or an aggregate of arts, without passing through the stage necessary for its invention. Arts, therefore, travel beyond the boundaries of tribes, languages, and philosophies, and are rapidly spread throughout the world. Tribes that to-day use the bow and arrow may to-morrow use the gun, though they have no knowledge of chemistry and metallurgy. The attempts of the archeologists of modern times to trace migrations, or to connect peoples by a genetic tie, have been to a large extent rendered vicious by the failure to recognize this principle. Tribes and nations, peoples, bodies politic, cannot be classified by arts: but the evolution of arts may be marked off in stages, as done by Morgan; and his stages are the best yet proposed, though he failed as an ethnologist in the attempt to classify races.

In the same manner, but to a less degree, scholars have failed to classify peoples by languages; for languages only to a limited extent represent genetic connections of peoples. Tribes speaking diverse languages have coalesced; and languages have thus been compounded, and language has supplanted language. A linguistic classification, therefore, is not completely ethnic, but it comes nearer to the truth than the technologic classification. If a classification by philosophies were attempted, it also would fail, though it would be superior to the philologic; for opinions last longer than words. A sociologic classification of peoples also fails to exhibit genetic relationships. Arts, languages, states, philosophies, may be classified, each to show genetic relationships; but they each and all together fail to classify mankind in a fundamental and philosophic manner.

Scholars have devoted much time and ingenuity to classify mankind by biologic characteristics, sought for in the color of the skin, the texture of the hair, the form of the skull, the relative proportion of parts, etc. These attempts have all failed. It is probable that in the early history of mankind biologic differentiation progressed so far as to produce some well-marked varieties; but the biologic method of evolution by the survival of the fittest was more and more repealed as the anthropologic methods of evolution gained ground, and the scattered and discrete tribes were more and more commingled by the union here and there of distinct streams of blood, by the spread of arts, that placed all peoples under conditions of artificial environment, and made them more and more independent of natural environment, and by various other anthropologic conditions too numerous and complex to be here set forth. But, altogether, the tendency to differentiate into distinct biologic peoples has been overcome, and the tendency to unification has been steadily increasing: so that the distinctions of biologic varieties of mankind, of which we now have but hints in the biologic characteristics remaining, are gradually being obliterated; and we may confidently predict that in the fourth stage, yet to be reached, race distinctions will be utterly lost.

In the short articles of this review an attempt has been made to give a synopsis of the work in question, to show the relation of 'Dynamic sociology' to current philosophy, and to point out its more important defects. Little space is left for that commendation which its intrinsic merits deserve. Mr. Ward's presentation of the subject is simple, clear, systematic, and courageous. For its preparation he has explored vast fields of thought; and his conclusions, however they may be questioned, cannot be ignored by those who are interested in modern philosophy. Ward's Dynamic sociology is America's greatest contribution to scientific philosophy.

ELEMENTARY METEOROLOGY.

Elementary meteorology, with meteorological charts and illustrations. By R. H. Scott. London, *Kegan Paul, Trench, & Co.*, 1883. 408 p. 8°.

This volume, the latest English contribution to the science of meteorology, is not a treatise, as the title indicates. It is, however, an excellent work, treating the subject from a modern stand-point, and sweeping away many untenable theories. We especially note the chapters on the barometer and on the formation of rain and hail. The descriptive chapters collecting all known facts relating to wind and ocean currents are very valuable and well presented.

Our author rejects the once seemingly satisfactory theory, attributing the south-west monsoon winds of India to the rising of heated air above the plains to the north-east of the Himalaya range, and also the theory that the existence of sea-breezes is due to the rising of heated air upon the land near oceans. He, however, adopts this theory of ascending currents of heated air in explaining the formation of cumulus-clouds. It is difficult to see how the atmosphere can be heated, save gradually, in strata parallel to the earth's surface, except on mountain sides. This is the theory adopted by Hann, who regards the cumulus-cloud as simply indicating the layer at which the air has the temperature of the dew-point.

Mr. Scott seems to indorse the theory that there is an ascending current in the centre of a barometric depression, though his storm-chart on p. 355 shows all the wind-directions near the low centre tangent to the isobars. This shows that the air-motion, which at the outside of the storm is directed more or less toward the centre, gradually becomes circular as it approaches the centre. Such a whirl moving over the earth's surface, losing a part of the air in its path, does not require any ascending current at its centre. The same may be said of our author's theory that rain can be formed by rising currents of heated air. In this case, not only is there the doubtful assumption of an ascending current, but the formation of rain under these circumstances seems disproved, in another place, by the author himself, who rejects the theory that any considerable precipitation can be produced by the mixture of masses of hot and cold air. Mr. Scott acknowledges that nothing definite is known as to the origin of atmospheric electricity; but his conjecture that the coalescence of cloud-droplets into rain-drops may be due to electricity will hardly be accepted by meteorologists at present. The description of a peculiar electrical manifestation observed in the Alps, July 10, 1863, is very similar to that given by Siemens while on Cheops pyramid, April 14, 1859.

The division of thunder-storms into heat and cyclonic is hardly applicable to the United States, where it appears as if no thunder-storms occur, except as largely influenced by, or directly dependent on, the presence of a barometric depression.

The error of more than forty million square miles in the earth's surface between the equator and 30° north latitude should be corrected in the next edition.

The statement, that at great depths in the ocean a probable uniform temperature of 32° F. prevails, has been disproved by the researches of Professor Verrill and the U. S. fish-commission.

We notice on p. 362 the surprising statement, that, as the central office of the U. S. weather bureau is in the eastern part of the country, there is a great advantage to those predicting storms by the use of the telegraph.

The chart of mean January isobars does not incorporate Stelling's work in Siberia, published in 1879, and accepted by Mohn in the last edition of his Meteorology. Mohn's chart shows a mean pressure over central Siberia of 780 mm. (30.79 in.), while the highest figure in Scott for the same region is 30.4 inches.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The thirty-second annual meeting of the American association was opened in the halls of the university of Minnesota, Minneapolis, Aug. 15, at 10.30 A.M. Dr. J. W. Dawson, the retiring president, introduced the president elect, Prof. C. A. Young, who briefly and gracefully expressed his thanks to the association for the distinction they had offered him. After welcomes spoken by the governor of the state and the mayor of the city, the principal address was made by the acting president of the university, Dr. W. W. Folwell, on behalf of the local committee. From his address we print the closing sentences: —

I should do a wrong to my city if I should leave upon you the impression that we are so overwhelmed and engrossed with our material labors as to have no care for the things of the mind and the higher life. If that were true, why should we welcome with so much sincere ardor the assemblage of your association? From the villages of New England, and the farmhouses of the Middle states, our people have brought that perennial curiosity, that thirst for knowledge, that intense though sombre imagination, which have given American civilization and American literature a cast and hue of its own. I must, in a word, praise our system of public schools, both city and state, which under able management and popular support cannot, we believe, be ranked below those of any communities of our size in the Union. Minnesota is the first place which has organized its secondary as well as its primary education, and offered to every child in the state a free course of studies, from the alphabet to the degree of master of arts. Our churches, goodly in size and number, may speak for the interests of religion. The future will attest the diligence and the fidelity of those who love music and the sister arts, of whom far older cities might be proud. It is thus, however, Mr. President, that we Minneapolitans, alert, pre-occupied, pause in the midst of our labors to welcome your already venerable association. We hail you as the survivors of a generation of great investigators, — the Sillimans, the Baches, the Morses, the Rogerses, who have made their own country famous and their own names as imperishable as science herself. We hail you as the worthy successors of such a generation, perpetuating and enlarging their work. In common with civilized people, we recognize the immense debt of the modern world to science; yet often, no doubt, while we are filling the sky with applause to some lucky inventor, we are not remembering the years, perhaps generations, of inconspicuous and painful labors, carried on in our studies and laboratories, which made the invention possible. Let the inventor have his glory and his profit without envy and without stint; but let us not fail to build the cenotaph of a thousand nameless geometers, star-gazers, and natural philosophers, who, working in silence and obscurity, without thought of fame or hope of reward, put it in his power to bless and captivate the world. We are grateful, therefore, to science for the telegraph and the microscope, for chloroform, for the photograph, for all the nameless applications of electricity. To science we owe that magnificent apparatus of transportation which is the crowning and distinctive feature of modern material life. To science we owe the thousand appliances which yield comfort and even elegance to the humblest household. Immense as are these contributions of science to material comfort and happiness, she has still, I think, performed greater services to mankind. The scientific method developed in the study of nature has spread to all branches of investigation. It has permeated all our education: it has boldly leaped the boundary between physics and metaphysics. It has even penetrated into industry and business and common life. The modern man first collects what knowledge he can about his enterprise or adventure, and assures himself of its value. He then makes the best quest he can in regard to the future. Then he assembles new facts, and, as the facts require, revises and amends his theory, till at length it becomes a working rule, maxim, and principle. He knows not merely how to know, but how to guess. The penetration of the scientific method into the operations of trade in great commercial centres is very conspicuous. We even endeavor to gamble scientifically. No Drew, or Armour, or Gould ever forms his corner without a most careful study of the situation; and his venture is his bet on the correctness of his theory. The farther extension of the scientific method, till it shall become the guide of conduct in the every-day life of all men, is now the chief problem in education.

In the next place, I think science may at length fairly claim to have wrought out, under great difficulties, a working hypothesis of our universe in the nebular hypothesis and its almost necessary corollary, 'evolution.' It cannot be denied that we are all, in some sense, evolutionists, — some of us against our prepossessions, some of us by insensible but progressive lapses. I am not competent to argue out this great theme. I feel bound to admit that the evolution doctrine, in one form or other, has quietly taken possession of the modern mind. Why may we not gladly accept it as a most useful working hypothesis of the mode of creation? I say, of the mode of creation; for the mystery of creation will forever mock the powers of man. Only this we know: that unless human consciousness is a juggle, and human language a mockery, there can never be to man a creation without a creator, nor an evolution without an evolver.

Another great service of science is the maintenance in the world of a body of men, a lay priesthood, devoted to the search for truth for its own sake and its own value. In a mercenary age, when, in the opinion of a distinguished contemporary, mercantilism has become a huge disease and excrescence on society, the example of such a body of men is of supreme value in the training of the new generations. Youth are formed, a wise Greek has taught us, not so much by schools as by the example of distinguished men.

A still greater benefit of science to mankind is the emancipation it has wrought for us, in the last generation, from superstition and the dominion of imaginary powers. It is no long time since it was generally believed by civilized men, that human affairs were under the control of the spirits of the air, good or evil. Men walked in cringing terror, by day and night, of demons and goblins damned. The earthquake, the tornado, the lightning's stroke, they looked upon as instruments of punishment for the sins of rulers and peoples. Thanks to science, the modern world has emerged from this cloud of gloom. We have some certain knowledge. Knowledge is not merely qualitative, but quantitative. Truth ever makes free. Above all, we know that all things in nature are governed by law, — law, "whose seat is in the bosom of God, whose voice is the harmony of the world." The beautiful conception of the Greeks of the universe as a kosmos, that is, an embodiment of divine and perfect order, is pervading modern thought. We now know that the phenomena of nature have no relation to human conduct, the impartial rain falling alike on the just and unjust. Men walk the earth erect and free, fearing no bogies, or warlocks, or demons of any kind. How vast and how blessed the relief to childhood! In dispelling superstition, science has incidentally wrought her greatest service to mankind in the purification of religion. The time is coming when grateful thanks will be rendered by the minister of religion for the emancipation which science has wrought for the faith; when the conflict of science and religion will only be remembered as the antagonism of crude theories on the one hand, and cruder superstitions on the other. Grateful we are for the knowledge which science has collected and collated and perpetuated to our use. All honor to the men who are consecrated to truth in her service! We may not know what marvels, far surpassing all the gifts of the past, the science of the future may reveal. Still, we must remember that the human mind is finite, while truth is infinite. The vast unknown engirdles our little circle of light. The mystery of life and death, no son of earth has ever penetrated. Welcome, then, the faith which points to the continuance of life in a land where study will be no weariness to the soul, where no veil of flesh will cloud the vision, where science and religion shall be forever one, where men shall know even as they were known.

To welcome you as a body of scientists, lovers and seekers after truth from love of it and of your kind, would be well worth our while, were it our only motive to improve and inspire the children and youth of our city. In doing you honor, we give them a lesson no books nor masters could impart. For their sake we renew our welcome.

President Young briefly responded: —

Gentlemen, — On behalf of my fellow-members of the association, I return you my sincerest thanks for the hearty welcome we have received to this magnificent state, this young and beautiful city, this vigorous, energetic, warm-hearted community. When you first invited us here, it was not in our power to come; but your second invitation we have accepted most gladly, and hope and believe that our meeting here will prove a benefit and pleasure to all concerned. Some of us have known you personally before, and most of us have long been more or less familiar at second hand with your state and city; and yet, I think, to many of us it is something like a new revelation to see for ourselves what a few years have accomplished. I am not enough of a Latin scholar to quote my Virgil well; but I have been all the time most forcibly reminded of the passage in which Æneas first comes in sight of rising Carthage. Most emphatically the work 'hails' here. We see no drones or sluggards; but every shoulder is at the wheel, and every thing is moving. It may, perhaps, seem to you sometimes, when in our sectional meetings we discuss some question about the stars, or some hypothesis as to the formation of rock-strata, or the structure of some worm or insect, that we are out of the current, and contributing nothing to the advancement of the world. But you know it is not so, and your invitation to hold our meeting here shows that you know it. The world advances, not on one line only, but on many, — on lines material, intellectual, spiritual. To some extent, the movements are indeed independent, but not very far. Any true advance on either line implies corresponding movement on each of the others, if not absolutely simultaneous, yet surely consequent. There is no need to ask you here how much this city owes to modern science, when I see on every side, in your streets and storehouses and mills, the practical application of the highest engineering, mechanical, and electric art; and in the future it is almost certain that science is to contribute still more liberally to business. But not mainly for this reason do I claim your regard to science; but because, made in the image of God as we are, knowledge and understanding are as truly wealth and power as lands and food and money.

I need not add that, as you have invited us here, so we on our part cordially invite you to attend all our meetings, to listen to the papers and their discussion. We cannot promise that every paper will be interesting to all, but each one, I think, will be able to select certain ones he will be glad to hear; and if any of you choose to join us, and enroll yourselves as promoters of the advancement of science, our membership is open on easy terms. Once more, gentlemen, we thank you for the cordial welcome, and address ourselves to our business, in the hope and confidence that our meeting here is to be in the highest degree pleasant and successful.

PROCEEDINGS OF SECTION A. — MATHEMATICS AND ASTRONOMY.

ADDRESS OF WILLIAM A. ROGERS, OF CAMBRIDGE, MASS., VICE-PRESIDENT OF THE SECTION, AUG. 15, 1883.

THE GERMAN SURVEY OF THE NORTHERN HEAVENS.

The illustrious Argelander was accustomed to say, in the quaint form of speech which he often employed, "The attainable is often not attained if the range of inquiry is extended too far." In no undertaking is there greater need of a judicious application of this sound maxim than in the systematic determination of the exact positions of all the stars in the visible heavens which fall within the reach of telescopes of moderate power.

The first subject which engaged the attention of the Astronomische gesellschaft, at its formation in 1865, was the proposition to determine accurately the co-ordinates of all the stars in the northern heavens down to the ninth magnitude. To this association of astronomers (at first national, but since become largely international, in its character and organization) belongs the credit of arranging a scheme of observations by which, through the co-operation of astronomers in different parts of the world, it has been possible to accomplish the most important piece of astronomical work of modern times. With a feasible plan of operations, undertaken with entire unity of purpose on the part of the observers to whom the several divisions of the labor were assigned, this great work is now approaching completion. While it is yet too early to speak with confidence concerning the definitive results which the discussion of all the observations are expected to show, we may with profit consider the object sought in the undertaking, the general plan of the work, the difficulties which have been encountered, and the probable bearing which the execution of the present work will have upon the solution of a problem concerning which we now know absolutely nothing with certainty, — a problem of which what we call universal gravitation is only one element, if, indeed, it be an element, — a problem which reaches farther than all others into the mysteries of the universe, — the motion of the solar and the sidereal systems in space.

Our first inquiry will be with respect to the condition of the question of stellar positions at the time when this proposal was made by the gesellschaft in 1865. All the observations which had been made up to this time possess one of two distinct characteristics. A portion of them were made without direct reference to any assumed system of stellar co-ordinates as a base, but by far the larger part are differential in their character. This remark holds more especially with reference to right ascensions. Nearly all of the observations of the brighter stars made previous to about 1830 were referred to the origin from which stellar co-ordinates are reckoned by corresponding observations of the sun; but since that date it has been the custom to select a sufficient number of reference stars, symmetrically distributed both in right ascension and declination, and whose co-ordinates were supposed to be well known. The unequalled Pulkova observations for the epoch 1845 form, I believe, the only exception to this statement. From the assumed system of primary stars are derived the clock errors and instrumental constants which are employed in the reduction of all the other stars observed. The positions of these secondary stars, therefore, partake of all the errors of the assumed fundamental system, in addition to the direct errors of observation.

The following list comprises the most important of the catalogues which have been independently formed; viz., Bessel's Bradley for 1755, the various catalogues of Maskelyne between 1766 and 1805, Gould's D'Agelet for 1783, Piazzi for 1800, Auwer's Cacciatore for 1805, Bessel for 1815, a few of the earlier catalogues of Pond, Brinkley for 1824, Bessel for 1825, Struve for 1825, Bessel for 1827, Struve for 1830, Argelander for 1830, and Pulkova for 1845.

The important catalogues of secondary stars published previous to 1865 are comprised in the following table.

[*Table omitted.*]

An analysis of these catalogues reveals four important facts:—

First, that a large share of the observations relate to bright stars, at least to stars brighter than the eighth magnitude.

Second, that in a large number of cases the same star is found in different catalogues, but that no rule is discoverable in the selection.

Third, that with the exception of the polar catalogues of Fedorenko, Groombridge, Schwerd, and Carrington, the double-star observations of Struve, and the zone observations of Bessel and Argelander, the observations were not arranged with reference to the accomplishment of a definite object.

Fourth, that each catalogue involves a system of errors peculiar to the observers, to the character of the instrument employed, and to the system of primary stars selected, but that thus far there had been no attempt to reduce the results obtained by different observers to a homogeneous system. In estimating the value of these observations it will be necessary to refer to the researches which have been made subsequent to 1865.

The systematic deviations of different catalogues in right ascension *inter se* were noticed at an early date by several astronomers; but the first attempt to determine the law of these variations seems to have been made by Safford in a communication to the monthly notices of the Royal astronomical society in 1861 (xxi. 245), 'On the positions of the Radcliffe catalogue.' I quote the equation derived by Safford, since it appears to be the first published account of a form of investigation almost exclusively followed since that time. It is as follows:—

Diff. of R. A. (Greenw. 12 Year cat. — Rad.) = $-0.38^s. + 0.32^s. \sin (\alpha + 5\text{ h. } 32\text{ m.})$. Extending this expression to terms of the second order, it may be put under the form, $\Delta = a$ constant $+ (m \sin \alpha + n \cos \alpha) + (m' \sin 2\alpha + n' \cos 2\alpha) +$, etc.

Safford also seems to have been the first to notice the connection between the observed residuals, and the errors in position of the primary stars employed. He remarks, "In investigating the causes which would give rise to such systematic discrepancies, I was struck with the fact that the same or nearly the same variations were apparent in the assumed places of the time stars for the years since 1845; that, if the correct positions of the time stars had been assumed, the resulting positions would have been free from these small errors." That the relation given by Safford should have been observed at all, is the more remarkable, since the primary stars upon which the Radcliffe positions depend are nearly the same as those employed at Greenwich. In reality, the systematic errors of both catalogues have since been found to be considerably greater than is here indicated, and the deviation pointed out by Safford is in the nature of a second difference. The speaker has shown (*Proc. Amer. acad.*, 1874, 182) that the weight of the errors of the provisional catalogue assumed, fell between the first and the third quadrants in the Radcliffe observations for 1841–42, on account of the omission of certain clock stars which were used at Greenwich.

Since the discordances which exist between two catalogues may arise from errors in either one or in both, it is clearly impossible either to determine the nature of the erorrs, or to assign their true cause, until a fundamental system has been established which is free both from accidental and from periodic errors,—from accidental errors, since a few abnormal differences may easily invalidate the determination of the errors which are really periodic; from periodic errors, because a relative system can only become an absolute one when one of the elements of which it is composed becomes absolute.

We owe to the researches of Newcomb, published in 1869–70, a homogeneous system of stellar co-ordinates in right ascension, which are probably as nearly absolute in their character as it is possible to obtain from the data at present available. He determined the absolute right ascensions of thirty-two stars of the first, second, and third magnitudes, and comprised between the limits —30° and + 46° declination. A comparison of the places of these stars for a given epoch, with the same stars in any catalogue for the same epoch, enables us to determine with considerable precision the system of errors inherent in that catalogue. Several circumstances prevent the exact determination of this relation. Among them may be mentioned the fact that Newcomb's system cannot safely be extended far beyond the limits in declination of the stars composing the system, that the stars are not symmetrically distributed in declination, and that the system of errors derived from bright stars is probably not the same as that derived from stars of less magnitude.

To a certain extent all of these objections have been met in the later discussion by Auwers, to which reference will presently be made. The substantial agreement of these two systems, independently determined, furnishes satisfactory evidence that we have at last obtained a foundation system with which it is safe to make comparisons, from which we may draw conclusions with comparative safety. When the catalogues which were formed between 1825 and 1865 are compared with Newcomb's fundamental system, through the medium of these thirty-two stars, the following facts are revealed.

a. The only catalogues in which there is freedom from both accidental and periodic errors are Argelander's Äbo catalogue for 1830, and the Pulkova catalogue for 1845. One is reminded, in this connecnection, of the remark of Pond, that "we can hardly obtain a better test of our power of predicting the future positions of stars than by trying by the same formula how accurately we can interpolate for the past. In a variety of papers which I have submitted to the Royal society, I have endeavored to show, that, with us, the experiment *entirely* fails."

b. During this interval the constant differences between the earlier catalogues and Newcomb's system vary between $+0.17^s$ for Pond, 1820; and -0.19^s for Pond, 1830: and for later catalogues, between $+0.07^s$ for Cambridge, 1860; and $+.02^s$ for Greenwich, 1860.

c. All the right ascensions determined at English observatories, and especially those which depend upon the positions published by the British Nautical almanac, are too large in the region of five hours, and too small in the region of eighteen hours. The general tendency of the constant part of the deviation from Newcomb's system is to neutralize the periodic errors in the region of five hours, and to augment them in the region of eighteen hours, where, in the case of a few catalogues, the error becomes as great as 0.10^s, — a quantity which can be readily detected from the observations of two or three evenings with an indifferent instrument, if it relates to a single star.

The right ascensions determined at French observatories exhibit systematic errors, which follow nearly the same law as those which characterize English observations.

Distinctively German observations are nearly free from systematic errors. As far as they exist at all, their tendency is to neutralize the errors inherent in distinctively English and French observations.

d. In the case of several catalogues, residual errors of considerable magnitude remain after the systematic errors depending upon the right ascensions have been allowed for. These errors are found to be functions of the declination of the stars observed, and without doubt have some connection with the form of the pivots of the instrument with which the observations were made. This statement holds true, especially with respect to the observations at Paris, Melbourne, and Brussels, between 1858 and 1871; and to the Washington observations between 1858 and 1861.

e. The systematic errors which exist in observations previous to 1865 follow the same law, and have nearly the same magnitude, as the errors of the same class which are inherent in the national ephemerides of the country in which they were made.

The British Nautical almanac and the Connaisance des temps are largely responsible for the perpetuation of this class of errors. For a few years before and after 1860, the ephemerides of the Nautical almanac were based upon the observations of Pond, which contain large periodic errors. It is found that the errors of this system have been transferred without sensible diminution to every catalogue in which the observations depend upon Nautical almanac clock stars. At English observatories it has been the custom to correct the positions of the fundamental stars by the observations of each successive year; but this has produced no sensible effect on the diminution of the periodic errors, which belong to the fundamental system. The periodic errors of the American ephemeris follow nearly the same law as the errors of the Nautical almanac, but their magnitude is somewhat reduced. The error of equinox is also less.

Wolfer's *Tab. reg.*, upon which the Berliner jahrbuch is based, has no well-defined systematic errors; and the correction for equinox is nearly the same in amount as in the American ephemeris, but with the opposite sign. The accidental errors seem to be rather larger than in the system of the American ephemeris.

f. A general estimate may be formed of the relative magnitudes of the errors of secondary catalogues by comparing the average error for each star of the primary catalogue. The numbers given below represent the average deviation for each star, expressed in hundredths of seconds, after the various catalogues have been reduced to a common equinox.

		Average error for each star.
Argelander	1830	1.1
Pulkova	1845	1.1
Greenwich	1845	2.0
Greenwich	1860	2.0
D'Agelet (Gould)	1783	2.2
Cape of Good Hope (Henderson)	1833	2.2
Greenwich	1850	2.2
Greenwich	1871	2.2
Paris	1867	2.4
Washington	1846-52	2.5
Struve	1830	2.5
Cape of Good Hope	1856	2.8
Radcliffe	1860	3.1
Greenwich	1840	3.1
Bessel	1825	3.2
Pond	1830	3.7
Gillis	1840	3.8
Madras (Taylor)	1830	3.9
Cape of Good Hope (Fallows)	1830	3.9
Radcliffe	1845	4.5
Armagh	1840	5.0
Piazzi	1800	5.3
Bessel's Bradley	1755	7.9
Lalande	1800	13.2
Lacaille	1750	24.9

It is obvious from these relations, that previous to about 1825 the magnitude of the accidental errors of observation, combined with the errors of reduction, prevent any definite conclusions with respect to the periodic errors inherent in these early observations. It is probable, also, that early observations of stars of the eighth and ninth magnitudes are subject to a class of errors peculiar to themselves, the nature of which it is now well-nigh impossible to determine.

The systematic errors in declination which belong to the various secondary catalogues named are even more marked than those in right ascension. The experience of Pond in 1833 is the experience of every astronomer who has attempted to compare observations of the same star made at different times, under different circumstances, with different instruments, and by different observers. He says, "With all these precautions, we do not find, by comparing the present observations with those of Bradley made eighty years ago under the same roof, and computed by the same table of refractions, that we can obtain by interpolation any intermediate catalogue which shall agree with the observations within the probable limits of error."

We owe to the investigations of Auwers (*Astron. nachr.*, nos. 1532–1536), the first definite system of declinations which is measurably absolute in its character. Yet the deviations of this system from that derived by the same author, but from much additional data in publication xiv. of the gesellschaft, is no less than 1.2″. The present difference outstanding between the Pulkova and the Greenwich systems at 10° south declination is 1.7″.

Within the past five years, the labors of Auwers, of Safford, of Boss, and of Newcomb, have resulted in the establishment of a mean system of declinations from which accidental errors may be considered to be eliminated in the case of a large number of stars; but the different systems still differ systematically *inter se* by quantities which are considerably greater than the probable error of any single position.

When the discussion of the question of a uniform determination of all the stars in the northern heavens to the ninth magnitude was taken up by the gesellschaft at its session in Leipzig in 1865, Argelander, who was then president of the society, appears to have been the only astronomer who had a clear apprehension of the difficulties of the problem. He alone had detected the class of errors whose existence subsequent investigations have definitely established. He alone had found a well-considered plan by which these errors might be eliminated, as far as possible, from future observations.

Argelander, however, always claimed for Bessel the first definite proposal of the proposition under consideration (see *Astron. nachr.*, i. 257). It was in pursuance of this plan that the zones between − 15° and + 15° in declination were observed. These zones were to form the ground-work of the Berlin charts; and Argelander, in the execution of the Bonn Durchmusterung, simply carried out the second part of Bessel's recommendation.

With the exception of the observations of Cooper at Makree observatory, and the charts of Chacornac, these two great works — the second being a continuation of the first, under a better and more feasible plan — are the only ones in existence which give us any knowledge of the general structure of the stellar system.

The observations of stars to the ninth magnitude, found in the catalogues of Bessel, Lalande, and Piazzi, form the ground-work of these charts. The co-ordinates in right ascension and declination of the stars found in these authorities were first reduced to the epoch 1800; the resulting right ascension being given to seconds of time, and the declination to tenths of minutes of arc. With these places as points of reference, all other stars were filled in, down to the ninth magnitude, by observations with equatorial instruments. The work was divided into zones of one hour each. Bremiker undertook five zones; Argelander and Schmidt, two; Wolfers, three; and Harding, two. The remaining zones were undertaken by different astronomers in widely separated localities.

The work seems to have been performed with somewhat unequal thoroughness, some zones containing nearly all the stars to the ninth magnitude, while in others a large number of stars having this limit in magnitude are wanting.

The Durchmusterung undertaken by Argelander at Bonn was a far more serious and well-considered undertaking. This unequalled work consists in the approximate determination of the co-ordinates of 324,198 stars situated between − 2° and + 90° declination. It includes stars to the 9.5 magnitude, the co-ordinates being given to tenths of minutes of time, and the declinations to tenths of minutes of arc.

The first definite proposal of this work undertaken by the gesellschaft, however, appears to have been made by Bruhns. In the course of a report upon the operations of the Leipzig observatory, he stated, that, in his view, the time had come for undertaking a uniform system of determinations of the places of stars to the ninth magnitude in the northern hemisphere by means of meridian circles; but he proposed, at the same time, that the positions of stars fainter than the ninth magnitude should be determined by means of differential observations with equatorial instruments. After explaining certain plans and arrangements relating particularly to his own observatory, he introduced the following resolution: —

"The Astronomische gesellschaft regards it as needful that all the stars to the ninth magnitude, occurring in the Durchmusterung, should be observed with meridian circles, and commissions the council to arrange for the execution of the work."

This proposal occasioned a long and somewhat animated discussion, in which Argelander, Hirsch, Bruhns, Förster, Schönfeld, and Struve took part.

Argelander declared himself surprised at this proposal, which called for the rapid realization of a plan of organization which he had been considering for years with the greatest care, the difficulties of which he had maturely considered, and the execution of which still demanded the most careful deliberation and preparation. One of the necessary preliminary steps was a plan which he had already prepared, published and presented to the society in an informal way, which provided for contemporaneous and corresponding observations of the brighter stars. As president of the society, he felt unequal to undertaking the charge which the acceptance of the resolution proposed would involve; as this procedure seemed to him premature without previous preparation. He would admit, however, that every call to action of this kind tended to stimulate enthusiasm, and should therefore be encouraged; but he felt obliged to ask the society not to require from him the immediate execution of the plan, but to intrust the serious consideration of it, and the preparation for it, to his zealous friends in the council.

Upon the motion of Struve, the society by a rising vote, expressed its confidence in the assurance of the president that he would bring forward his plan at the proper time, as soon as the means for its execution could be assured.

At the meeting held at Bonn in 1867, Argelander again brought up the subject in a communication which appears to have been an exhaustive discussion of the whole problem. This paper is not printed in the proceedings of the gesellschaft; but at its conclusion a committee was appointed to take definite action with respect to the recommendations which it contained. The committee reported at the same session; and their report, which is published in the place of the paper presented by Argelander, is probably identical in substance with it. The plan proposed and adopted was finally published in the form of a programme, in which the details of the work are arranged with considerable minuteness. As this programme has been widely distributed, it seems unnecessary to give any thing more than a general abstract of it. Since it differs in a few minor points from the first report of the committee at the Bonn meeting, the essential features of this report will be given instead of an abstract of the programme itself.

They are as follows: —

a. The limits in declination of the proposed series of observations are — 2° and + 80°. The first limit was chosen on account of the lack of suitable fundamental stars south of the equator. It is probable, also, that Argelander had a suspicion of the fact, since proven, that the uncertainty with respect to the systematic errors of southern stars is, of necessity, considerably greater than for northern stars, and that on this account it would be better to defer this part of the work until further investigations in this direction could be made.

The limit + 80° was chosen because the repetition of Carrington's observations between 81° and 90° was considered superfluous, and Hamburg had already undertaken the extension of Carrington's observations from 81° to 80°.

b. Within these limits, all stars in the Durchmusterung to the ninth magnitude, and, in addition, all stars which have been more exactly observed by Lalande, by Bessel at Koenigsberg, and by Argelander at Bonn, are to be observed.

c. The observations are to be differential. The clock errors are not to be found from the fundamental stars usually chosen for this purpose, and the equator point corrections are not to be derived from observations at upper and lower culminations, but these elements are to be derived from a series of 500 or 600 stars, distributed as uniformly as possible over the northern heavens. The exact co-ordinates of these stars are to be determined at Pulkova,. thus securing the unity necessary in order to connect in one system the observations of different zones.

d. Every star is to be observed twice. If the two observations differ by a quantity greater than ought to be expected, a third observation will be necessary.

e. In order to facilitate the work, it will be desirable to use only three or four transit threads, and only one or two microscopes. In order to facilitate the reductions to apparent place, the working-list of stars should be comprised within narrow limits.

f. Before the commencement and after the close of each zone, two or three fundamental stars are to be observed upon the same threads and with the same microscopes as were used in the zone observations. When the seeing is not good, and when for any other cause it seems desirable, one or more fundamental stars may be observed in the course of the zone. The number and selection of the stars will depend upon the character of the instrument employed. If it remains steady for several hours, and has no strongly marked flexure or division errors, or if these errors have been sharply determined, the fundamental stars may be situated ten degrees or fifteen degrees away from the zone limits. However, there must remain many things for which no general rule can be given, and which must be left to the judgment of the observer, aided by an accurate knowledge of his instrument.

g. With a Repsold or a Martin instrument, one microscope will be sufficient, if its position with respect to the whole four can be determined. It will be sufficient, if the change in position during the observations can be interpolated to 0.2″.

h. It will be desirable to divide beforehand the zones into such time intervals that the observations can be easily made.

i. Zones exceeding one and one-half or at the most two hours are not advisable, first, because the zero points will be too far apart, and, second, because a longer duration will involve too much fatigue physically and mentally.

At the conclusion of this report, all the astronomers present who were willing to take part in this work were requested to communicate with the council, stating the region of the heavens which they preferred to select for observation.

At this meeting, Berlin, Bonn, Helsingfors, Leipzig, and Mannheim signified their intention to share in the work. Leiden also expressed its intention of taking part as soon as the work already undertaken should be completed.

When the stars to be observed had been selected from the Durchmusterung, it was found that the number would not vary much from 100,000, requiring rather more than 200,000 observations. Preparations for the work of observation were immediately commenced; and, by the time of the next report in 1869, considerable progress had been made.

In the report for this year, the provisional places of a catalogue of 539 fundamental stars were published. This catalogue is composed of two parts. The list of hauptsterne consists of 336 stars to the fourth magnitude, observed at Pulkova by Wagner with the large transit instrument, and by Gyldén with the Ertel vertical circle. The list of zusat-sterne consists of 203 stars fainter than the fourth magnitude. As the details of the work in the formation of the provisional places of the stars of this list are not given in the report, it is not quite clear upon what authority they rest. The work assigned to the Pulkova observatory by thé zone commission was the exact determination of the places of the stars of this list. The observations were undertaken by Gromadski with the Repsold meridian circle. In accordance with the plan adopted, each star was observed eight times, — four times in each position of the instrument. The observations were differential with respect to the hauptsterne.

The results were published by Struve in 1876; and the places there given were used in the first reduction of the Harvard-college observations for 1874–75, and perhaps in some other cases.

About this time a change seems to have been made in the original plan with respect to the formation of the final catalogue of fundamental stars, of which I have been unable to find a clear account. The original intention was to make the positions depend entirely upon the observations at Pulkova. The zone commission established by the gesellschaft, however, committed the formation of this catalogue to Auwers; and it is to him that we owe the most complete and the most perfect catalogue of fundamental stars yet published. The Pulkova system for 1865 was adopted as the basis; but, in order to obtain greater freedom from accidental errors for individual stars, the final catalogue was obtained by combining with the Pulkova series, the Greenwich observations from 1836 to 1876, the Harvard-college observations for 1871–72, the Leipsic observations, in declination only, between 1866 and 1870, and the Leiden observations in declination between 1864 and 1870. Before this combination was made, however, these observations were all reduced to the Pulkova system.

The following observatories have taken part in the zone observations: —

Observatories.	Limits of zones in declination.	Observatories.	Limits of zones in declination.
Nicolajeff . . .	− 2° to + 1°	Lund	+35° to +40°
Albany	+ 1 " + 5	Bonn	+40 " +50
Leipsic	+ 4 " +10	Harvard college .	+50 " +55
Leipsic	+10 " +15	Helsingfors . .	+55 " +60
Berlin	+15 " +25	Christiana . . .	+65 " +70
Cambridge (Eng.)	+25 " +30	Dorpat	+70 " +75
Leiden	+30 " +35	Kasan	+75 " +80

The zone between −2° and +1° was originally undertaken at Palermo, that between +1° and +4° at Neuchâtel, that between +4° and +10° at Mannheim, and that between +35° and +40° at Chicago.

In the latter case, the great fire at Chicago crippled the resources of the observatory to such an extent, that Safford was compelled to relinquish the work, which was at that time quite far advanced.

The chief items of interest in connection with this work are found in the following tabular statement: —

[*Table omitted.*]

Attention was called, at an early date, to the importance of continuing the survey of the northern heavens beyond the southern limit fixed by Argelander. The preparation necessary for the execution of this work consisted in the extension of the Durchmusterung to the tropic of Capricorn. This was undertaken by Schönfeld at Leipsic.

In the report to the gesellschaft at the meeting held at Stockholm in 1877, he has given an account of this work, in which he stated that it was sufficiently near completion to invite the consideration of the question of the meridian circle determinations of the places of stars to the ninth magnitude. The lack of southern fundamental stars whose positions were well determined was still a hinderance to the immediate commencement of the work. Relatively more stars of this class are required than in the northern observations, in order to eliminate the inequalities due to refraction. Schönfeld stated, that, while the burden of the determination of the places of these southern fundamental stars must rest mainly upon southern observations, it seemed necessary to connect them with the Pulkova system by a connecting link (mittelglied), through observations at some observatory well situated for this purpose. At this meeting Sande Bakhuysen, at Leiden, gave notice of intention to take part in this work. Gyldén urged the importance of securing the co-operation of Melbourne; and Peters suggested the advantage of securing Washington as an additional 'mean term' (V. J. S. 1877, p. 265).

The next reference to this work is contained in the vierteljahrsschrift for 1881, xv. p. 270. A list of 303 southern stars is here given, whose exact places were at that time being determined at Leiden and at the Cape of Good Hope. This list was selected by Schönfeld and Sande Bakhuysen, in a way to meet the requirements referred to in previous discussions.

A final catalogue of 83 southern fundamental stars by Auwers appears in this number of the vierteljahrsschrift. The places depend upon the same authorities as for the northern stars, with the addition of the Cape of Good Hope catalogue for 1860, Williamstown, Melbourne for 1870, and Harvard college (Safford) for 1864. For stars not observed at Pulkova, the general catalogue of Yarnall (1858–1861), and the Washington observations, with the new meridian circle between 1872 and 1875, were employed. As in the case of the northern stars, these observations are all reduced to the Pulkova system for 1865. It is understood that the co-ordinates of the list of 303 stars are to depend upon this extension of the general system of publication xiv. to the limits required by the southern Durchmusterung of Schönfeld.

It would be surprising if all the conditions of success were fulfilled in the first execution of a work having the magnitude, and involving the difficulties, of the scheme of observations undertaken under the auspices of the gesellschaft. The extent of the discordances which are to be expected between the results obtained by different observers can only be ascertained when the observations by which the different zones are to be connected have been reduced. Each observer extended the working-list of his own zone 10′ north and south; and it is expected that a sufficient number of observations of this kind has been made to determine the systematic relations existing between the co-ordinates of each zone with those of its neighbor.

It is probable, however, that the experience of Gill will be repeated on a larger scale. In 1878 he solicited the co-operation of astronomers in the determination of the co-ordinates of twenty-eight stars, which he desired to employ in the reduction of his heliometer observations of the planet Mars for the purpose of obtaining the solar parallax. The results obtained at twelve observatories of the first class are published in vol. xxxix. p. 99, of the monthly notices of the Royal astronomical society. Notwithstanding the fact that the final values obtained at each observatory depend upon several observations, the average difference between the least and the greatest results, obtained by different observers for each star, is 0.24ˢ. in right ascension and 2.3″ in declination. In four cases the difference in right ascension exceeds 3.0, and in four cases the difference in declination exceeds 3.0.″

Even after the results are reduced to a homogeneous system, the following outstanding deviations from a mean system are found: —

Authority.	Δ α	Δ δ	Authority.	Δ α	Δ δ
	s.	″		s.	″
Koenigsberg . .	+.005	−0.71	Leiden	−.053	−0.19
Melbourne . . .	+.026	−0.49	Paris	+.055	+0.01
Pulkova	+.005	+0.36	Washington . .	−.120	+0.78
Leipsic	+.049	+0 40	Harvard college,	−.072	+0 09
Greenwich . . .	+ 009	−0.56	Cordoba . . .	−.032	−0.20
Berlin	+.044	+0.67	Oxford	+.076	+0.21

The observations of a second list of twelve stars, one-half of the number being comparatively bright, and the remaining half faint, showed no marked improvement, either with respect to the magnitude of errors which could be classed as accidental, or in regard to the systematic deviations from a mean system.

This discussion revealed one source of discordance which will doubtless affect the zone observations; viz., the difference between right ascensions determined by the eye-and-ear method, and those determined with the aid of the chronograph.

The programme of the gesellschaft makes no provision for the elimination of errors which depend upon the magnitude of the stars observed; but special observations have been undertaken at several observatories for the purpose of defining the relation between the results for stars of different magnitudes. At Harvard-college observatory, the direct effect of a reduction of the magnitude has been ascertained by reducing the aperture of the telescope by means of diaphragms. Beside this, the observations have been arranged in such a manner that an error depending upon the magnitude can be derived from an investigation of the observations upon two successive nights.

At Leiden, at Albany, and perhaps at other observatories, the effect of magnitude has been determined by observations through wire gauze. But notwithstanding all the precautions which have been taken in the observations, and which may be taken in the reductions, it will undoubtedly be found that the final results obtained will involve errors which cannot be entirely eliminated.

In the experience of the speaker, two other sources of error have been detected. It has been found, that there is a well-defined equation between the observations, which is a function of the amount, and the character of the illumination of the field of the telescope. It has also been found that observations made under very unfavorable atmospheric conditions differ systematically from those made under favorable conditions. When the seeing was noted as very bad, it is found that the observed right ascensions are about .08ˢ too great, and that the observed declinations are about 0.8″ too great.

There are doubtless other sources of error which the discussion of the observations will bring to light. The effect of the discovery of these and other errors will probably be to hasten the repetition of the zone observations under a more perfect scheme, framed in such a manner as to cover all the deficiencies which experience has revealed, or may yet reveal. One would not probably go far astray in naming the year 1900 as the mean epoch of the new survey. If the observations are again repeated in 1950, sufficient data will then have been accumulated for at least an approximate determination of the laws of siderial motion.

What is the present state of our knowledge upon this subject? It can be safely said that it is very limited. First of all, it cannot be affirmed that there is a sidereal system in the sense in which we speak of the solar system. In the case of the solar system, we have a central sun about which the planets and their satellites revolve in obedience to laws which are satisfied by the hypothesis of universal gravitation. Do the same laws pervade the inter-stellar spaces? Is the law of gravitation indeed universal? What physical connection exists between the solar system and the unnumbered and innumerable stars which form the galaxy of the heavens? Do these stars form a system which has its own laws of relative rest and motion? or is the solar system a part of the stupendous whole? Does the solar system receive its laws from the sidereal system? or has Kepler indeed pierced the depths of the universe in the discovery of the laws which gave him immortality? Are we to take the alternative stated by Ball, — either that our sidereal system is not an entirely isolated object, or its bodies must be vastly more numerous or more massive than even our most liberal interpretation of observations would seem to warrant? Are we to conclude, for example, that stars like 1830 Groombridge and α Centauri, "after having travelled from an infinitely great distance on one side of the heavens, are now passing through our system for the first and only time, and that after leaving our system they will retreat again into the depths of space to a distance which, for any thing we can tell, may be practically regarded as infinite"? Can we assert with Newcomb, that in all probability the stars do not form a stable system in the sense in which we say that the solar system is stable, — that the stars of this system do not revolve around definite attractive centres? Admitting that the solar system is moving through space, can we at the present moment even determine whether that motion is rectilinear, or curved, to say nothing of the laws which govern that motion? How much of truth is there in the conjectures of Wright, Kant, Lambert, and Mitchel, or even in the more serious conclusions of Moedler, that the Alcyone of the Pleiades is the central sun about which the solar system revolves?

These are questions which, if solved at all, must be solved by a critical study of observations of precision accumulated at widely separated epochs of time. The first step in the solution has been taken in the systematic survey of the northern heavens undertaken by the gesellschaft, and in the survey of the southern heavens at Cordoba by Dr. Gould. The year 1875 is the epoch about which are grouped the data which, combined with similar data for an epoch not earlier than 1950, will go far towards clearing up the doubts which now rest upon the question of the direction and the amount of the solar motion in space; and it cannot be doubted that our knowledge of the laws which connect the sidereal with the solar system will be largely increased through this investigation. The basis of this knowledge must be the observed proper motions of a selected list of stars, so exactly determined that the residual mean error shall not affect the results derived; or, failing in this, of groups of stars symmetrically distributed over the visible heavens, sufficient in number to affect an elimination of the accidental errors of observation, without disturbing the equilibrium of the general system.

For an investigation of this kind, a complete system of zone observations, at widely separated intervals, will afford the necessary data, if the following conditions are fulfilled.

First: The proper motions must be derived by a method which does not involve an exact knowledge of the constants of precession. In every investigation with which I am acquainted, the derived proper motions are functions of this element.

Second: The general system of proper motions derived must be free from systematic errors. Errors of this class may be introduced either through the periodic errors inherent in the system of fundamental stars employed in the reduction of the zone observations, or in a change in the constants of precession. It is in this respect that the utmost precaution will be required. If from any cause errors of even small magnitude are introduced into the general system of proper motions at any point, the effect of these errors upon the values of the co-ordinates at any future epoch will be directly proportional to the interval elapsed. We can, therefore, compute the exact amount of the accumulated error for any given time.

When this test is applied to the fundamental stellar systems independently determined by Auwers, Safford, Boss, and Newcomb, we find the following deviations *inter se* at the end of a century.

	Maximum mean deviation in a century.		Maximum systematic deviation in a century.	
	$\Delta\alpha$	$\Delta\delta$		
Auwers *minus* Safford . . .	-0.22^s	$+0.2''$	0.23^s	$1.1''$
Auwers *minus* Boss	–	+0.8	–	2.1
Auwers *minus* Newcomb . .	−0.09	+0.8	0.06	2.2

It is the common impression, that both the direction and the amount of the motion of the solar system in space are now well established. The conclusions of Struve upon this point are stated in such explicit language that it is not surprising that this impression exists. He says, "The motion of the solar system in space is directed to a point in the celestial sphere situated on the right line which joins the two stars measured from π and ω Herculis. The velocity of this motion is such that the sun, with the whole cortége of bodies depending on him, advances annually in the direction indicated, through a space equal to one hundred and fifty-four million miles."

It must be admitted that there is a general agreement in the assignment by different investigators of the co-ordinates of the solar apex. This will be seen from the following tabular values.

Authorities.	Right ascension.	Declination.
Herschel, 1783	257° 00′	+25° 00′
Prevost	230 00	+25 00
Klugel, 1789	260 00	+27 00
Herschel, 1805	245 52	+49 38
Argelander, 1837	257 49	+28 50
Lundahl	252 24	+14 26
Struve	261 22	+37 36
Galloway	260 01	+34 23
Mädler	261 38	+39 54
Airy	256 54	+34 29
	261 29	+26 44
Dunkin	261 14	+32 55
	263 44	+25 00

In estimating the value which should be attached to these results, several considerations must be taken into account.

(*a*) All of the results except those of Galloway depend practically upon the same authorities at one epoch, viz., upon Brodley.

(*b*) The deviations *inter se* probably result, in a large measure, from the systematic errors inherent in one or both of the fundamental systems from which the proper motions were derived. For example, Lundahl employed Pond as one of his authorities, and it is in Pond's catalogue that the most decided periodic errors exist.

(*c*) Brot in 1812, Bessel in 1818, and Airy in 1860, reached the conclusion that the *certainty* of the movement of the solar system towards a given point in the heavens could not be affirmed.

(*d*) The problem is indirect. In the case of a member of the solar system, exact data will determine the exact position in orbit at a given time; but here we have neither exact data, nor can we employ trigonometrical methods in the solution. We simply find that the observed proper motions are probably somewhat better reconciled under the hypothesis of an assumed position of the apex of the solar motion. The method of investigation employed by Safford, who has of late years given much attention to this subject, consists in assuming a system of co-ordinates for the pole of the solar motion, from which is determined the direction each star would have if its own proper motions were zero. Comparing this direction with the observed direction as indicated by the observed proper motion, equations of condition are formed from which a correction is found to the assumed position of the apex, by the methods of least squares.

It must always be kept in mind, that the quantities with which we must deal in this investigation are exceedingly minute, and that the accidental errors of observation are at any time liable to lead to illusory results. The weak link in the chain of Mädler's reasoning is to be found here. I think we can assume 0.2″ as the limit of precision in the absolute determination of the co-ordinates of any star, however great the number of observations upon which it depends. Beyond this limit it is impossible to go, in the present date of instrumental astronomy.

It is safe to say, that there is not a single star in the heavens whose co-ordinates are known with certainty within this limit. Do not misunderstand me. Doubtless there are many stars in which the error will at some future time be found to fall within this limit. The law of probabilities requires this, if the maximum limit falls within 1″. But who is prepared to select a particular star, and say that the absolute position of this star in space cannot be more than 0.2″ in error?

e. At present an arbitrary hypothesis is necessary in the discussion of the problem. Airy assumed that the relative distances of the stars are proportional to their magnitudes; and he found slightly different results according to different modes of treatment. Safford assumed that the distances are, at least approximately, in inverse proportion to the magnitude of the proper motions. The general result of his investigations, up to this point, is, that there is some hope of using the solar motion as a base, to advance our knowledge of stellar distances. Later investigations have been made by De Ball, but the details have not yet come to hand. It is understood, however, that his results coincide in a general way with those previously obtained.

It is clear from this brief review, that we have here a field of investigation worthy of the highest powers of the astronomer. The first step has been taken in the survey of the heavens carried on under the auspices of the gesellschaft. It remains for the astronomers of the present generation to solve the difficulties which now environ the problem, and prepare the way for a more perfect scheme of observation in the next century.

PAPERS READ BEFORE SECTION A.

The total solar eclipse of May 6, 1883.

BY EDWARD S. HOLDEN, OF WASHBURN OBSERVATORY, MADISON, WIS.

THIS eclipse had the longest totality of any which has been observed.

An expedition was sent by the National academy of sciences and the U. S. coast-survey jointly, under direction of a committee from the former. Expenses were met by an appropriation of $5,000 by congress and by the National academy of sciences from a fund left by Professor Watson. The navy department also placed the U. S. steamer Hartford at the disposal of the academy, to transport the expedition from Peru to Caroline Island, where the eclipse was to be observed, and thence to Honolulu.

The efforts of Mr. Rockwell to provide money by private subscription for this undertaking, though directly unsuccessful, prepared the way by drawing public attention.

Professor Young was the chairman of the committee of the National academy of sciences: it was at one time hoped that he would take charge of the observing-party, but this proved impracticable. The reports of different members of the party are to be submitted to the National academy of sciences in November. Mr. Holden has, however, permission of the academy to present an account of the observation before the American association. It is understood that the present is not by any means a final report. This especially applies to the observations of Dr. Hastings, from which that gentleman concludes that the solar corona is chiefly a phenomenon due to the diffraction of the solar light at the moon's limb. The computations to demonstrate this are not yet at hand, but are to be completed in a few weeks.

The American party consisted of Edward S. Holden, director of Washburn observatory, Madison, Wis.; Charles S. Hastings, professor of physics in the Johns Hopkins university, Baltimore, Md.; Charles H. Rockwell, Tarrytown, N.Y.; E. D. Preston, aid U. S. coast and geodetic survey, Washington, D.C.; Winslow Upton, U.S. signal-office, Washington, D.C.; and Ensign S. J. Brown, U.S.N., U. S. naval observatory, Washington, D.C.

The original six members of the party were joined, on April 20, by four volunteer observers, all officers of the U. S. ship Hartford: these were Lieut. E. F. Qualtrough, U.S.N.; Passed assistant-surgeon W. S. Dixon, U.S.N.; Midshipman W. S. Fletcher, U.S.N.; and Midshipman J. G. Doyle, U.S.N.

On March 11 the party was strengthened by the joining (at Colon) of the two English gentlemen who were sent out by the Royal society of London to make photographic observations of the eclipse, under instructions from J. Norman Lockyer, Esq., F.R.S., and Capt. W. de W. Abney, R.E., of the science and art department of the South Kensington museum. These were H. A. Lawrance, London, Eng., and C. Ray Woods, London, Eng.

During the stay of the party on Caroline Island

(April 21 to May 9), ten petty officers and men of the Hartford remained, and rendered very intelligent assistance.

In all, the party on the island consisted of twenty-two persons.

After giving details of the proceedings of the expedition, its arrival, and the preparations for the eclipse, Mr. Holden states, as to the event itself, that the following atmospheric conditions prevailed: The sky proved clear at first contact, cloudy at intervals till near totality, clear during totality except a slight haze in its first minutes, cloudy a few minutes after third contact, and finally clear at fourth contact.

The meteorological observations (for which due credit is given to the members of the party that had them in charge) are noteworthy. In two weeks, April 25 to May 9, twenty showers were recorded; but the rainfall in each was very small, the total in the two weeks being about 8 inches. Half of this fell during the only considerable disturbance of the weather, which took place May 4, when it rained from midnight to 9.50 A.M.

The barometer was notably uniform. Its diurnal movements were plainly marked; the maxima being at 9 A.M. and P.M., the minima at 3 A.M. and P.M. The indications of the thermometer were very constant. The daily range was 9.3°, the highest reading 89.3°, the lowest 72.4°, the daily maximum at noon, the minimum at 6 A.M. The relative humidity ranged from 70 per cent at midday to 84 in early morning, and at no time fell below 61. The island lies in the region of the south-east trades, but the wind (which was very steady) blew constantly between north and east. The average velocity of the wind was 6.05 miles; the largest during twenty-four hours was 212 miles, the least 59 miles; the highest velocity, registered in a squall, was 16 miles per hour.

The botanical and zoölogical observations are not yet ready for publication. During the voyage a series of observations was made by Mr. Upton on southern variable stars. Dr. Hastings and Mr. Holden, while on the island, discovered twenty-three new double stars, a list of which has appeared in SCIENCE.

In preparing for the eclipse, Mr. Holden assigned to each observer a single duty, not requiring him to move from one instrument to another. The excellent photographic apparatus, prepared under the direction of Prof. W. Harkness of the U.S. naval observatory, was not used: the entire field of photography was left to the English party accompanying our own, and to the French party under M. Janssen, who were very successful in photographing the corona.

The combination of polariscope and telescope was used, but not with successful results, the apparatus proving unsuitable. Dr. W. S. Dixon, who attended to a telescopic examination of the details of the inner corona, will report on the same separately, giving a drawing of the corona. With the spectroscope, the chief point of observation was as to the relative lengths of the line 1474 east and west of the sun. At second contact, this line was 12′ longitude east and 3′ west. The length of 1474 east diminished, while 1474 west increased. At mid-totality these were equal. Before the third contact, the appearances were reversed: 1474 west was longer and brighter than 1474 east.

At the beginning of totality, the lines C, D_3, F, and (near G) were seen brilliant but very short. At mid-eclipse the spectrum was deliberately examined. On a continuous spectrum, two lines only were seen: 1474 *bright*, and the D line *dark*. C, E, b, F, were certainly wanting. Near the end of totality, C, D_3, and F appeared again, very short. Five seconds after second contact, four curved lines were seen, — C, D_3, 1474, F. A light cloud passed over the sun; and on its disappearance the spectrum showed a small line, of about one-third the height of the others, between 1474 and F. One hundred seconds after second contact, three coronal rings took the place of the lines: they were red, yellowish-green, and green, and are supposed to be C, D_3, and 1474. Two hundred seconds after second contact, the red ring was decidedly the brightest, and it continued to increase in brightness during sixty seconds. Two hundred and ninety seconds after second contact, the four curved lines, C, D_3, 1474, F, appeared. The reversal of the bright lines at third contact was observed. The change was instantaneous, or nearly so. The reversal of the Fraunhofer lines was not seen. The only bright line seen for the first 190 seconds was 1474. A dark line was seen, which was probably D.

Mr. Rockwell, using a Rutherford grating and a narrow slip tangential to the limb, reported that 1474 K was not seen until a minute and a half had passed. It was followed 4′ or 5′ west of the limb, twice; and it was seen only on the western side of the moon. Two green lines were also seen, each brighter and broader than 1474, but much shorter.

Due credit is given by Mr. Holden to each of the observers of the party. His own observations were confined to a search for the planet Vulcan, reported to exist by Professors Watson and Swift. Mr. Holden's search continued during the whole of totality (five minutes and twenty-five seconds), with a six-inch telescope with a power of 44 and field of 57′ in declination. He saw every star on the map which he had previously published in SCIENCE (Feb. 23, 1883), down to the sixth magnitude, inclusive, except the thirty-sixth magnitude stars nearest to the sun; and he saw only these stars. One of the stars of the map was of the same magnitude as Watson's 'Vulcan.' This was a conspicuous object. No star half so bright as this could possibly have escaped observation. Mr. Holden is therefore confident that Vulcan did not exist within the limits swept over. Mr. Holden also determined the direction of the motion of the diffraction bands before and after totality. This was an observation which he could not make successfully in Colorado in 1878, and which he believes has not been before made.

A new method of investigating the flexure corrections of a meridian circle.

BY PROF. W. A. ROGERS OF CAMBRIDGE, MASS.

THE error due to refraction, the flexure of the circle itself, and the astronomical flexure, the three being functions in themselves, are most prolific errors respecting flexures of a meridian circle.

The theory which suggested itself was arrived at from the use on the telescope of a level of a different construction from any the author had ever seen. He had been a disbeliever in a level, but this device converted him into an advocate of the level. The level tube is attached to a plate, and the plate attached to the cube of the telescope. Then set the telescope at the north point, and reverse it to the south, reading the circle north and south. It would be much better were the point fixed upon a ring so that it can be readily placed at any inclination.

Results of tests with the almacantar, in time and latitude.

BY S. C. CHANDLER, OF CAMBRIDGE, MASS.

THE instrument which has been named the 'almacantar' was described and figured in a paper presented to the association at its meeting in 1880. In its general nature it is an equal altitude instrument. A hollow rectangular trough containing mercury revolves horizontally on an upright central pillar. The trough contains a float which is perfectly free to obtain equilibrium, while it is constrained to revolve with the trough. The float carries a telescope which turns on a horizontal axis, and can be clamped at any desired altitude. When this instrument is revolved on its vertical axis, any given point in the field of view describes a horizontal small circle, or almacantar, in the heavens. The transits of stars over a series of horizontal lines will thus afford means of determining the altitude of the instrument, the error of the clock, the latitude or the declinations of stars, by a proper distribution of the observations in azimuth.

A higher degree of accuracy is attainable by this instrument than by a transit or a zenith telescope of same size. The author's comparison of results is as follows: The probable error of a single star in determining the clock error is only $\pm0.05^s$ or $\pm0.06^s$. With a transit instrument of the same size, the quantity is not less than $\pm0.08^s$. With the almacantar the probable error in determining the latitude of a single star is $\pm0.55''$, including the error of the star's place. This is about equal to the probable error of a pair of stars by Talcott's method, with the larger telescopes of the United-States coast-survey.

The instrument was a small one, — $1\frac{3}{4}$ inches aperture and 25 inches focus. It was constructed for experiment only, in a provisional way, at a cost of $150. There are obvious defects in design and construction: when these are remedied, the error can be much reduced.

A series of observations with this instrument are given by the author, for the latitude of a pier about 80 feet north of the Harvard-college observatory. The value obtained by averaging these is $0.7''$ less than given by Professor Peirce in his discussion of the prime vertical transit observations taken by the Messrs. Bond, and adopted as the standard value of the latitude of the observatory. The author concludes that Professor Peirce's value is too large by fully three-quarters of a second. By way of proof the author gives a series of observations on the five stars used by Professor Peirce. These are compared with those of Auwers and Boss, and the correction of the hitherto accepted value of the latitude now indicated by the almacantar is thereby confirmed.

The clock errors of two nights selected at random, as given by the almacantar, were exhibited by the author. The results both in time and latitude would be considered satisfactory with an ordinary instrument of two or three times the size. The almacantar can be made much larger than the one under trial, certainly of five or six inches aperture, with corresponding increase of precision along with greater optical power. Its mechanical construction is simple, and reduces the sources of error. Thus in the older instruments there are involved: 1°. The accurate construction of parts, as of pivots, level, graduated circles. 2°. Fixity of mounting, to avoid a shifting of the instrumental plane. 3°. Rigidity of the instrument itself, to secure constancy of collimation and flexure. In the almacantar only the last condition has to be satisfied, and it is by far the easiest of the three to be attained mechanically.

The author regards the principle of flotation adopted as being as delicate an indication of the direction of gravity as is obtained by the spirit-level.

The almacantar gives promise of a new instrumental resource in the higher practical astronomy. It is competent to deal with the most delicate problems. It will evade some of the minute sources of error that still cling to meridian instruments. Especially, it furnishes a method for obviating difficulties, hitherto regarded as almost insuperable, connected with flexure and refraction, in observations with the meridian circle.

Internal contacts in transits of the inferior planets.

BY J. R. EASTMAN, OF WASHINGTON, D.C.

THE author began by reviewing the different values obtained in observing transits of Venus, and by computations thereon since 1761. Eventually it became certain that the differences of these values depended chiefly upon the computer's interpretation of the observer's record. The phenomenon known as the 'black drop' began to be considered as an element in the calculation. Stone regarded it as a necessary phenomenon. He gave an explanation of its origin, and stated that the moment when a dark ligament appears to connect the apparent limbs of the sun and Venus is the time of *real* internal contact. The second phase, when the limbs of Venus and the sun appear in contact, Stone says, is 'the *apparent* internal contact.'

In 1876 M. André, the astronomer in charge of the French expedition to Nouméa, in 1874, announced that "the bridge, black ligament, or black drop, as it is variously called, is a necessary phenomenon under certain circumstances, and not merely accidental." He noticed, however, that "it is always possible to get rid of the ligament, and reduce the phenomenon to geometrical constants, either (*a*) by reducing sufficiently the intensity of the source of light, or augmenting the absorbing power of the dark glass employed; or (*b*) by covering the object-glass with a dark diaphragm composed of rings alternately full and empty, all very thin, and bearing a certain proportion to the focal length of the lens."

These results and opinions of M. André were not generally known at the time of the transit of Mercury in 1878; although his theories were confirmed by his observations at Utah at that date, the results being published by him in 1881. The black drop was seen and recognized in 1878 by many observers of Mercury; some evidently regarding their success in finding it as a proof of accuracy of observation, others apologizing for failing to perceive the phenomenon.

The author of this paper regards it as noteworthy, that every observer, so far as ascertained, who got, by means of shade-glasses, the best definition of the sun's limbs, with an illumination less than the eye could easily bear, did not see any trace of the black drop. Before seeing any account of M. André's experiments, and having given little attention to his deductions announced by Father Perry, the author became independently convinced, after observation of the transit of Mercury in 1878, that the theory of a *necessary* black drop was fallacious.

While, in 1874, many American observers perceived the black drop, none appear to have seen it, among the eight American parties organized by the transit-of-Venus commission of 1882.

The paper winds up with an account of the observations of contact at the transit-of-Venus station at Cedar Keys, Fla., last December. The observation of first contact was prevented by a cloud covering a part of the sun's disk. On the disappearance of the cloud, the illumination was reduced by a sliding shade-glass, till easily endured by the eye. The definition of the sun's limb was perfect. When haze or cirri interfered, a less density of shade-glass was permitted; the steadiness and definition of the limb remaining, and that of Venus being 'all that could be desired,' with no modification, at the edge of the disk, of its dense black color.

Before the second contact, the entire disk of Venus was visible for several minutes. The portion beyond the sun's disk was bordered by a narrow line of light much less bright than the limb of the sun, and of a lighter tint. About one minute before contact, the apparent motion of the cusps of the sun, as they closed around the planet, noticeably increased, although the movement was perfectly steady. The cusps swept around the planet in a line of sunlight of the same tint as adjacent parts of the sun. This line was as narrow as could be seen with the power used, — 216 diameters, — and was free from tremors or pulsations. There was no agitation in the limb of either body near the point of contact, no trace of black drop, ligament, or band, no change of tint or color on the limb of Venus, and no indication of any clinging of the limbs. The contact was as easily, and perhaps as accurately, observed as the transit of a star within 8° of the pole, under the best conditions. The uncertainty of noting the time of the visible contact could not have been greater than three-tenths of a second. The phenomena at the third contact were similar to those at the second, but, of course, in a reversed order.

In conclusion, the author urges his belief, founded upon his own experience as well as on study of the work of other observers, that, with a properly arranged telescope and shade-glass, no observer need have trouble from any phase of the 'black drop.' To attain this end satisfactorily, the observer of contacts must have no other purpose in view than such observation. The study of any branch of solar physics, or searching for some new thing, may, and probably will, detract from the accuracy of his work, which should be confined to obtaining the record of a good definition of the sun's limb, as a reference-point in the passage of the limb of the planet.

An improved method of producing a dark-field illumination of lines ruled upon glass.

BY PROF. W. A. ROGERS OF CAMBRIDGE, MASS.

By repeated and careful tests the author found that by letting the light, which is held at an angle of 45°, into the telescope, and then splitting the rays by means of two opposite mirrors, throwing them on the horizontal line, an almost perfect light is secured. Thereby it becomes practicable to see with distinctness stars of the smaller magnitudes upon a dark field.

Other astronomers present expressed a preference for the use of red light. Professor Rogers claimed that his method was better for minute observation.

Physical phenomena on the planet Jupiter.

BY G. W. HOUGH OF CHICAGO, ILL.

The rapid motion of revolution of the planet, by changing the positions of the markings on the surface to our line of sight, makes great apparent differences in their shapes and sizes. This has perhaps been the occasion of reports of sudden and great changes upon the surface. The changes are not sudden, but are gradual; and many of the features are permanent. Minor changes are constantly in progress in the equatorial belts. The author recently observed the belt drifting down toward the red spot; but although it partly surrounded it, they did not coalesce, and the spot forced a scallop into the belt, — a very curious phenomenon. The author saw a satellite pass over this red spot, though the satellites are not visible when on the white part of the disk. He had also had a chance to compare shadows of satellites on the disk and on the spot, and both are dark. The red spot has seemingly retrogaded during the past four years; that is to say, the rotation of Jupiter has seemingly increased from 9 h. 55 m. 33 s., to 9 h. 55 m. 38 s. The future observer should attend more carefully to what he sees, and theorize afterward.

French observations on the solar eclipse of May 6, 1883.

BY DR. J. JANSSEN OF PARIS, FRANCE.

A LETTER from the French astronomer Dr. Janssen, who passed through this country on his return from an eclipse expedition, was addressed by him for the use of the association to Professor Eastman, who translated it, and read the translation in Section A. It was thus entered as one of the papers. Dr. Janssen says, —

"The principal object of the observations was the study of the dark rays in the corona. The visibility of these rays depends more on the light-power of the instrument than upon the perfection of the images. At first the ordinary brilliant rays which the corona presents were recognized; but what was new, and more complete than ever expected, was that the background of the coronal spectrum presented the Fraunhofer's spectrum. All the dark rays were theoretically visible. Phenomena were observed, which indicated that there were some portions of the corona which reflected, much more abundantly than others, the light emanating from the solar sphere: this would indicate the existence of cosmic matter circulating around the sun. The rings of Rispighi were not found arranged symmetrically around the sun. The light of the corona was strongly and radially polarized. All these things were associated with the problem of circumsolar cosmic matter. The observations went to show that no important intra-mercurial planet exists."

Some hitherto undeveloped properties of squares.

BY O. S. WESTCOTT OF CHICAGO, ILL.

THE paper began by ascribing due credit to a method for obtaining squares and square roots, described by Samuel Emerson in 1865. The principles and details of that method were briefly summarized. Mr. Westcott then stated the general principles of his own method, which is very expeditious. He first shows that the tens and units figures of all perfect squares of numbers, from 26 to 49 inclusive, are the same as the tens and units figures of perfect squares of numbers from 24 to 1 inclusive. A table is presented as follows:

$(24)^2 = 576$, add 100, $= 676 = (26)^2$
$(23)^2 = 529$, add 200, $= 729 = (27)^2$
$(22)^2 = 484$, add 300, $= 784 = (28)^2$

and so on, to

$(1)^2 = 1$, add 2400, $= 2401 = (49)^2$

To determine the square of any number between 25 and 50, find the corresponding number below 25, and augment its square by the number of hundreds indicated by its remoteness from 25. Or, more conveniently, take the excess above 25 as hundreds, and augment by the square of what the number lacks of 50.

Thus: $(43)^2 = (43 - 25) . 100 + (50 - 43)^2$
$= \quad 1800 \quad + \quad 49 \quad = 1849$

Conversely: To obtain the square root of 1764. The root is plainly between 25 and 50. The tens and units figures indicate 8. Therefore the square root of 1764 is $50 - 8 = 42$.

It is further observable, that the tens and units figures of perfect squares of numbers from 51 to 99 inclusive, are the same as the tens and units figures of the squares of numbers from 49 to 1 inclusive. Since $4 \times$ any number of hundreds + 25, 50, or 75, gives an exact number of hundreds, it follows that the tens and units figures of the squares of numbers less than 25 represent all the possible combinations of figures in those orders of units for *all* square numbers. The terminations of all perfect square numbers are 22 in all: viz., 00, 01, 04, 09, 16, 21, 24, 25, 29, 36, 41, 44, 49, 56, 61, 64, 69, 76, 81, 84, 89, 96.

The following rule is then deduced: To square any number from 50 to 100, take twice the excess above 50 as hundreds, and augment by the square of what the number lacks of 100.

Thus: $(89)^2 = 200\,(89 - 50) + (100 - 89)^2$
$= \quad 7800 \quad + \quad 121 \quad = 7921$

Conversely, $\sqrt{3249}$: The root is plainly between 50 and 60; the tens and units figures indicate 7; therefore $\sqrt{3249} = 50 + 7 = 57$.

For greater convenience it is noted, that in such a case as $\sqrt{7921}$ the root is $50 + 39$ or $100 - 11$, and it is easier to use the latter form. That is, if the root is in the fourth quarter of the hundred, subtract the number indicated by the tens and units from 100, and the difference is the root. Thus $\sqrt{8281} = 100 - 9 = 91$.

To square any number from 100 to 200, take four times the excess above 100 as hundreds, and augment by the square of what the number lacks of 200.

To square any number from 125 to 250, take one-half the excess above 125 as thousands, and augment by what the number lacks of 250.

By a series of steps of this character, the author gives methods for squaring higher numbers, and conversely for obtaining their square roots. A choice of methods is also indicated. The facility which was obtained by such means was deftly illustrated on the blackboard by the author, who in a few seconds performed such exploits as raising 5 to the 16th power, and then showed in detail the processes which he had mentally executed. The paper sets forth the reason for each rule, deducing it from the usual binomial theorem, with almost obvious simplicity.

The demonstrations were received by the section with hearty applause. In response to an inquiry, Mr. Westcott stated, that he had been very successful in teaching this method in classes, about a tenth of his pupils becoming rapid experts in the methods of solution, which were especially useful in handling quadratic equations, and determining at a glance whether a given number is or is not a perfect square.

PROCEEDINGS OF SECTION B. — PHYSICS.

ADDRESS OF H. A. ROWLAND OF BALTIMORE, MD., VICE-PRESIDENT OF SECTION B, AUG. 15, 1883.

A PLEA FOR PURE SCIENCE.[1]

THE question is sometimes asked us as to the time of year we like the best. To my mind, the spring is the most delightful; for nature then recovers from the apathy of winter, and stirs herself to renewed life. The leaves grow, and the buds open, with a suggestion of vigor delightful to behold; and we revel in this ever-renewed life of nature. But this cannot always last. The leaves reach their limit; the buds open to the full, and pass away. Then we begin to ask ourselves whether all this display has been in vain, or whether it has led to a bountiful harvest.

So this magnificent country of ours has rivalled the vigor of spring in its growth. Forests have been levelled, and cities built, and a large and powerful nation has been created on the face of the earth. We are proud of our advancement. We are proud of such cities as this, founded in a day upon a spot over which, but a few years since, the red man hunted the buffalo. But we must remember that this is only the spring of our country. Our glance must not be backward; for however beautiful leaves and blossoms are, and however marvellous their rapid increase, they are but leaves and blossoms after all. Rather should we look forward to discover what will be the outcome of all this, and what the chance of harvest. For if we do this in time, we may discover the worm which threatens the ripe fruit, or the barren spot where the harvest is withering for want of water.

I am required to address the so-called physical section of this association. Fain would I speak pleasant words to you on this subject; fain would I recount to you the progress made in this subject by my countrymen, and their noble efforts to understand the order of the universe. But I go out to gather the grain ripe to the harvest, and I find only tares. Here and there a noble head of grain rises above the weeds; but so few are they, that I find the majority of my countrymen know them not, but think that they have a waving harvest, while it is only one of weeds after all. American science is a thing of the future, and not of the present or past; and the proper course of one in my position is to consider what must be done to create a science of physics in this country, rather than to call telegraphs, electric lights, and such conveniences, by the name of science. I do not wish to underrate the value of all these things: the progress of the world depends on them, and he is to be honored who cultivates them successfully. So also the cook who invents a new and palatable dish for the table benefits the world to a certain degree; yet we do not dignify him by the name of a chemist. And yet it is not an uncommon thing, especially in American newspapers, to have the *applications* of science confounded with pure science; and some obscure American who steals the ideas of some great mind of the past, and enriches himself by the application of the same to domestic uses, is often lauded above the great originator of the idea, who might have worked out hundreds of such applications, had his mind possessed the necessary element of vulgarity. I have often been asked, which was the more important to the world, pure or applied science. To have the applications of a science, the science itself must exist. Should we stop its progress, and attend only to its applications, we should soon degenerate into a people like the Chinese, who have made no progress for generations, because they have been satisfied with the applications of science, and have never sought for reasons in what they have done. The reasons constitute pure science. They have known the application of gunpowder for centuries; and yet the reasons for its peculiar action, if sought in the proper manner, would have developed the science of chemistry, and even of physics, with all their numerous applications. By contenting themselves with the fact that gunpowder will explode, and seeking no farther, they have fallen behind in the progress of the world; and we now regard this oldest and most numerous of nations as only barbarians. And yet our own country is in this same state. But we have done better; for we have taken the science of the old world, and applied it to all our uses, accepting it like the rain of heaven, without asking whence it came, or even acknowledging the debt of gratitude we owe to the great and unselfish workers who have given it to us. And, like the rain of heaven, this pure science has fallen upon our country, and made it great and rich and strong.

To a civilized nation of the present day, the applications of science are a necessity; and our country has hitherto succeeded in this line, only for the reason that there are certain countries in the world where pure science has been and is cultivated, and where the study of nature is considered a noble pursuit. But such countries are rare, and those who wish to pursue pure science in our own country must be prepared to face public opinion in a manner which requires much moral courage. They must be prepared to be looked down upon by every successful inventor whose shallow mind imagines that the only pursuit of mankind is wealth, and that he who obtains most has best succeeded in this world. Everybody can comprehend a million of money; but how few can comprehend any advance in scientific theory, especially in its more abstruse portions! And this, I believe, is one of the causes of the small number of persons who have ever devoted themselves to work of the higher order in any human pursuit. Man is a gregarious animal, and depends very much, for his happiness, on the sympathy of those around him; and it is

[1] In using the word 'science,' I refer to physical science, as I know nothing of natural science. Probably my remarks will, however, apply to both, but I do not know.

rare to find one with the courage to pursue his own ideals in spite of his surroundings. In times past, men were more isolated than at present, and each came in contact with a fewer number of people. Hence that time constitutes the period when the great sculptures, paintings, and poems were produced. Each man's mind was comparatively free to follow its own ideals, and the results were the great and unique works of the ancient masters. To-day the railroad and the telegraph, the books and newspapers, have united each individual man with the rest of the world: instead of his mind being an individual, a thing apart by itself, and unique, it has become so influenced by the outer world, and so dependent upon it, that it has lost its originality to a great extent. The man who in times past would naturally have been in the lowest depths of poverty, mentally and physically, to-day measures tape behind a counter, and with lordly air advises the naturally born genius how he may best bring his outward appearance down to a level with his own. A new idea he never had, but he can at least cover his mental nakedness with ideas imbibed from others. So the genius of the past soon perceives that his higher ideas are too high to be appreciated by the world: his mind is clipped down to the standard form; every natural offshoot upwards is repressed, until the man is no higher than his fellows. Hence the world, through the abundance of its intercourse, is reduced to a level. What was formerly a grand and magnificent landscape, with mountains ascending above the clouds, and depths whose gloom we cannot now appreciate, has become serene and peaceful. The depths have been filled, and the heights levelled, and the wavy harvests and smoky factories cover the landscape.

As far as the average man is concerned, the change is for the better. The average life of man is far pleasanter, and his mental condition better, than before. But we miss the vigor imparted by the mountains. We are tired of mediocrity, the curse of our country. We are tired of seeing our artists reduced to hirelings, and imploring congress to protect them against foreign competition. We are tired of seeing our countrymen take their science from abroad, and boast that they here convert it into wealth. We are tired of seeing our professors degrading their chairs by the pursuit of applied science instead of pure science; or sitting inactive while the whole world is open to investigation; lingering by the wayside while the problem of the universe remains unsolved. We wish for something higher and nobler in this country of mediocrity, for a mountain to relieve the landscape of its monotony. We are surrounded with mysteries, and have been created with minds to enjoy and reason to aid in the unfolding of such mysteries. Nature calls to us to study her, and our better feelings urge us in the same direction.

For generations there have been some few students of science who have esteemed the study of nature the most noble of pursuits. Some have been wealthy, and some poor; but they have all had one thing in common, — the love of nature and its laws. To these few men the world owes all the progress due to applied science, and yet very few ever received any payment in this world for their labors.

Faraday, the great discoverer of the principle on which all machines for electric lighting, electric railways, and the transmission of power, must rest, died a poor man, although others and the whole world have been enriched by his discoveries. And such must be the fate of the followers in his footsteps for some time to come.

But there will be those in the future who will study nature from pure love, and for them higher prizes than any yet obtained are waiting. We have but yet commenced our pursuit of science, and stand upon the threshold wondering what there is within. We explain the motion of the planet by the law of gravitation; but who will explain how two bodies, millions of miles apart, tend to go toward each other with a certain force?

We now weigh and measure electricity and electric currents with as much ease as ordinary matter, yet have we made any approach to an explanation of the phenomenon of electricity? Light is an undulatory motion, and yet do we know what it is that undulates? Heat is motion, yet do we know what it is that moves? Ordinary matter is a common substance, and yet who shall fathom the mystery of its internal constitution?

There is room for all in the work, and the race has but commenced. The problems are not to be solved in a moment, but need the best work of the best minds, for an indefinite time.

Shall our country be contented to stand by, while other countries lead in the race? Shall we always grovel in the dust, and pick up the crumbs which fall from the rich man's table, considering ourselves richer than he because we have more crumbs, while we forget that he has the cake, which is the source of all crumbs? Shall we be swine, to whom the corn and husks are of more value than the pearls? If I read aright the signs of the times, I think we shall not always be contented with our inferior position. From looking down we have almost become blind, but may recover. In a new country, the necessities of life must be attended to first. The curse of Adam is upon us all, and we must earn our bread.

But it is the mission of applied science to render this easier for the whole world. There is a story which I once read, which will illustrate the true position of applied science in the world. A boy, more fond of reading than of work, was employed, in the early days of the steam-engine, to turn the valve at every stroke. Necessity was the mother of invention in his case: his reading was disturbed by his work, and he soon discovered that he might become free from his work by so tying the valve to some movable portion of the engine, as to make it move its own valve. So I consider that the true pursuit of mankind is intellectual. The scientific study of nature in all its branches, of mathematics, of mankind in its past and present, the pursuit of art, and the cultivation of all that is great and noble in the world, — these are the highest occupation of mankind. Commerce, the applications of science, the accumulation of wealth, are necessities which are a curse to those with high ideals, but a blessing to that portion of the world which has neither the ability nor the taste for higher pursuits.

As the applications of science multiply, living becomes easier, the wealth necessary for the purchase of apparatus can better be obtained, and the pursuit of other things beside the necessities of life becomes possible.

But the moral qualities must also be cultivated in proportion to the wealth of the country, before much can be done in pure science. The successful sculptor or painter naturally attains to wealth through the legitimate work of his profession. The novelist, the poet, the musician, all have wealth before them as the end of a successful career. But the scientist and the mathematician have no such incentive to work: they must earn their living by other pursuits, usually teaching, and only devote their surplus time to the true pursuit of their science. And frequently, by the small salary which they receive, by the lack of instrumental and literary facilities, by the mental atmosphere in which they exist, and, most of all, by their low ideals of life, they are led to devote their surplus time to applied science or to other means of increasing their fortune. How shall we, then, honor the few, the very few, who, in spite of all difficulties, have kept their eyes fixed on the goal, and have steadily worked for pure science, giving to the world a most precious donation, which has borne fruit in our greater knowledge of the universe and in the applications to our physical life which have enriched thousands and benefited each one of us? There are also those who have every facility for the pursuit of science, who have an ample salary and every appliance for work, yet who devote themselves to commercial work, to testifying in courts of law, and to any other work to increase their present large income. Such men would be respectable if they gave up the name of professor, and took that of consulting chemists or physicists. And such men are needed in the community. But for a man to occupy the professor's chair in a prominent college, and, by his energy and ability in the commercial applications of his science, stand before the local community in a prominent manner, and become the newspaper exponent of his science, is a disgrace both to him and his college. It is the deathblow to science in that region. Call him by his proper name, and he becomes at once a useful member of the community. Put in his place a man who shall by precept and example cultivate his science, and how different is the result! Young men, looking forward into the world for something to do, see before them this high and noble life, and they see that there is something more honorable than the accumulation of wealth. They are thus led to devote their lives to similar pursuits, and they honor the professor who has drawn them to something higher than they might otherwise have aspired to reach.

I do not wish to be misunderstood in this matter. It is no disgrace to make money by an invention, or otherwise, or to do commercial scientific work under some circumstances. But let pure science be the aim of those in the chairs of professors, and so prominently the aim that there can be no mistake. If our aim in life is wealth, let us honestly engage in commercial pursuits, and compete with others for its possession. But if we choose a life which we consider higher, let us live up to it, taking wealth or poverty as it may chance to come to us, but letting neither turn us aside from our pursuit.

The work of teaching may absorb the energies of many; and, indeed, this is the excuse given by most for not doing any scientific work. But there is an old saying, that where there is a will there is a way. Few professors do as much teaching or lecturing as the German professors, who are also noted for their elaborate papers in the scientific journals. I myself have been burdened down with work, and know what it is; and yet I here assert that all *can* find time for scientific research if they desire it. But here, again, that curse of our country, mediocrity, is upon us. Our colleges and universities seldom call for first-class men of reputation, and I have even heard the trustee of a well-known college assert that no professor should engage in research because of the time wasted! I was glad to see, soon after, by the call of a prominent scientist to that college, that the majority of the trustees did not agree with him.

That teaching is important, goes without saying. A successful teacher is to be respected; but if he does not lead his scholars to that which is highest, is he not blameworthy? We are, then, to look to the colleges and universities of the land for most of the work in pure science which is done. Let us therefore examine these latter, and see what the prospect is.

One, whom perhaps we may here style a practical follower of Ruskin, has stated that while in this country he was variously designated by the title of captain, colonel, and professor. The story may or may not be true, but we all know enough of the customs of our countrymen not to dispute it on general principles. All men are born equal: some men are captains, colonels, and professors, and therefore all men are such. The logic is conclusive; and the same kind of logic seems to have been applied to our schools, colleges, and universities. I have before me the report of the commissioner of education for 1880. According to that report, there were 389,[1] or say, in round numbers, 400 institutions, calling themselves colleges or universities, in our country! We may well exclaim that ours is a great country, having more than the whole world beside. The fact is sufficient. The whole earth would hardly support such a number of first-class institutions. The curse of mediocrity must be upon them, to swarm in such numbers. They must be a cloud of mosquitoes, instead of eagles as they profess. And this becomes evident on further analysis. About one-third aspire to the name of university; and I note one called by that name which has two professors and 18 students, and another having three teachers and 12 students! And these instances are not unique, for the number of small institutions and schools which call themselves universities is very great. It is difficult to

[1] 364 reported on, and 25 not reported.

decide from the statistics alone the exact standing of these institutions. The extremes are easy to manage. Who can doubt that an institution with over 800 students, and a faculty of 70, is of a higher grade than those above cited having 10 or 20 students and two or three in the faculty? Yet this is not always true; for I note one institution with over 500 students which is known to me personally as of the grade of a high school. The statistics are more or less defective, and it would much weaken the force of my remarks if I went too much into detail. I append the following tables, however, of 330 so-called colleges and universities: —

218	had from	0 to 100	students.
88	" "	100 " 200	"
12	" "	200 " 300	"
6	" "	300 " 500	"
6	over	500	

Of 322 so-called colleges and universities: —

206	had	0 to 10	in the faculty.
99	"	10 " 20	" "
17	"	20 or over	" "

If the statistics were forthcoming, — and possibly they may exist, — we might also get an idea of the standing of these institutions and their approach to the true university idea, by the average age of the scholars. Possibly also the ratio of number of scholars to teachers might be of some help. All these methods give an approximation to the present standing of the institutions. But there is another method of attacking the problem, which is very exact, but it only gives us the *possibilities* of which the institution is capable. I refer to the wealth of the institution. In estimating the wealth, I have not included the value of grounds and buildings, for this is of little importance, either to the present or future standing of the institution. As good work can be done in a hovel as in a palace. I have taken the productive funds of the institution as the basis of estimate. I find: —

234	have below	$500,000.
8	"	between $500,000 and $1,000,000.
8	"	over $1,000,000.

There is no fact more firmly established, all over the world, than that the higher education can never be made to pay for itself. Usually the cost to a college, of educating a young man, very much exceeds what he pays for it, and is often three or four times as much. The higher the education, the greater this proportion will be; and a university of the highest class should anticipate only a small accession to its income from the fees of students. Hence the test I have applied must give a true representation of the possibilities in every case. According to the figures, only 16 colleges and universities have $500,000 or over of invested funds, and only one-half of these have $1,000,000 and over. Now, even the latter sum is a very small endowment for a college; and to call any institution a university which has less than $1,000,000, is to render it absurd in the face of the world. And yet more than 100 of our institutions, many of them very respectable colleges, have abused the word 'university' in this manner. It is to be hoped that the endowment of the more respectable of these institutions may be increased, as many of them deserve it; and their unfortunate appellation has probably been repented of long since.

But what shall we think of a community that gives the charter of a university to an institution with a total of $20,000 endowment, two so-called professors, and 18 students! or another with three professors, 12 students, and a total of $27,000 endowment, mostly invested in buildings! And yet there are very many similar institutions; there being 16 with three professors or less, and very many indeed with only four or five.

Such facts as these could only exist in a democratic country, where pride is taken in reducing every thing to a level. And I may also say, that it can only exist in the early days of such a democracy; for an intelligent public will soon perceive that calling a thing by a wrong name does not change its character, and that truth, above all things, should be taught to the youth of the nation.

It may be urged, that all these institutions are doing good work in education; and that many young men are thus taught, who could not afford to go to a true college or university. But I do not object to the education, — though I have no doubt an investigation would disclose equal absurdities here, — for it is aside from my object. But I do object to lowering the ideals of the youth of the country. Let them know that they are attending a school, and not a university; and let them know that above them comes the college, and above that the university. Let them be taught that they are only half-educated, and that there are persons in the world by whose side they are but atoms. In other words, let them be taught the truth.

It may be that some small institutions are of high grade, especially those which are new; but who can doubt that more than two-thirds of our institutions calling themselves colleges and universities are unworthy of the name? Each one of these institutions has so-called professors, but it is evident that they can be only of the grade of teachers. Why should they not be so called? The position of teacher is an honored one, but is not made more honorable by the assumption of a false title. Furthermore, the multiplication of the title, and the ease with which it can be obtained, render it scarcely worth striving for. When the man of energy, ability, and perhaps genius is rewarded by the same title and emoluments as the commonplace man with the modicum of knowledge, who takes to teaching, not because of any aptitude for his work, but possibly because he has not the energy to compete with his fellow-men in business, then I say one of the inducements for first-class men to become professors is gone.

When work and ability are required for the position, and when the professor is expected to keep up with the progress of his subject, and to do all in his power to advance it, and when he is selected for these reasons, then the position will be worth working for, and the successful competitor will be honored accordingly. The chivalric spirit which prompted Faraday to devote his life to the study of nature may actuate a few noble men to give their life to scientific work; but, if we wish to cultivate this highest class of men in science, we must open a career for them worthy of their efforts.

Jenny Lind, with her beautiful voice, would have cultivated it to some extent in her native village; yet who would expect her to travel over the world, and give concerts for nothing? and how would she have been able to do so if she had wished? And so the scientific man, whatever his natural talents, must have instruments and a library, and a suitable and respectable salary to live upon, before he is able to exert himself to his full capacity. This is true of advance in all the higher departments of human learning, and yet something more is necessary. It is not those in this country who receive the largest salary, and have positions in the richest colleges, who have advanced their subject the most: men receiving the highest salaries, and occupying the professor's chair, are to-day doing absolutely nothing in pure science, but are striving by the commercial applications of their science to increase their already large salary. Such pursuits, as I have said before, are honorable in their proper place; but the duty of a professor is to advance his science, and to set an example of pure and true devotion to it which shall demonstrate to his students and the world that there is something high and noble worth living for. Money-changers are often respectable men, and yet they were once severely rebuked for carrying on their trade in the court of the temple.

Wealth does not constitute a university, buildings do not: it is the men who constitute its faculty, and the students who learn from them. It is the last and highest step which the mere student takes. He goes forth into the world, and the height to which he rises has been influenced by the ideals which he has consciously or unconsciously imbibed in his university. If the professors under whom he has studied have been high in their profession, and have themselves had high ideals; if they have considered the advance of their particular subject their highest work in life, and are themselves honored for their intellect throughout the world, — the student is drawn toward that which is highest, and ever after in life has high ideals. But if the student is taught by what are sometimes called good teachers, and teachers only, who know little more than the student, and who are often surpassed and even despised by him, no one can doubt the lowered tone of his mind. He finds that by his feeble efforts he can surpass one to whom a university has given its highest honor; and he begins to think that he himself is a born genius, and the incentive to work is gone. He is great by the side of the molehill, and does not know any mountain to compare himself with.

A university should not only have great men in its faculty, but have numerous minor professors and assistants of all kinds, and should encourage the highest work, if for no other reason than to encourage the student to his highest efforts.

But, assuming that the professor has high ideals, wealth such as only a large and high university can command is necessary to allow him the fullest development.

And this is specially so in our science of physics. In the early days of physics and chemistry, many of the fundamental experiments could be performed with the simplest apparatus. And so we often find the names of Wollaston and Faraday mentioned as needing scarcely any thing for their researches. Much can even now be done with the simplest apparatus; and nobody, except the utterly incompetent, need stop for want of it. But the fact remains, that one can only be free to investigate in all departments of chemistry and physics, when he not only has a complete laboratory at his command, but a friend to draw on for the expenses of each experiment. That simplest of the departments of physics, namely, astronomy, has now reached such perfection that nobody can expect to do much more in it without a perfectly equipped observatory; and even this would be useless without an income sufficient to employ a corps of assistants to make the observations and computations. But even in this simplest of physical subjects, there is great misunderstanding. Our country has very many excellent observatories: and yet little work is done in comparison, because no provision has been made for maintaining the work of the observatory; and the wealth which, if concentrated, might have made one effective observatory which would prove a benefit to astronomical science, when scattered among a half-dozen, merely furnishes telescopes for the people in the surrounding region to view the moon with. And here I strike the keynote of at least one need of our country, if she would stand well in science; and the following item which I clip from a newspaper will illustrate the matter: —

"The eccentric old Canadian, Arunah Huntington, who left $200,000 to be divided among the public schools of Vermont, has done something which will be of little practical value to the schools. Each district will be entitled to the insignificant sum of $10, which will not advance much the cause of education."

Nobody will dispute the folly of such a bequest, or the folly of filling the country with telescopes to look at the moon, and calling them observatories. How much better to concentrate the wealth into a few parcels, and make first-class observatories and institutions with it!

Is it possible that any of our four hundred colleges and universities have love enough of learning to unite with each other and form larger institutions? Is it possible that any have such a love of truth that they are willing to be called by their right name? I fear not; for the spirit of expectation, which is analogous to the spirit of gambling, is strong in the American breast, and each institution which now, except in name, slumbers in obscurity, expects in time to bloom out into full prosperity. Although many of them are under religious influence, where truth is inculcated, and where men are taught to take a low seat at the table in order that they may be honored by being called up higher, and not dishonored by being thrust down lower, yet these institutions have thrust themselves into the highest seats, and cannot probably be dislodged.

But would it not be possible to so change public opinion that no college could be founded with a less endowment than say $1,000,000, or no university with less than three or four times that amount? From the report of the commissioner of education, I learn that such a change is taking place; that the tendency towards large institutions is increasing, and that it is principally in the west and south-west that the multiplication of small institutions with big names is to be feared most, and that the cast is almost ready for the great coming university.

The total wealth of the four hundred colleges and universities in 1880 was about $40,000,000 in buildings, and $43,000,000 in productive funds. This would be sufficient for one great university of $10,000,000, four of $5,000,000, and twenty-six colleges of $2,000,000 each. But such an idea can of course never be carried out. Government appropriations are out of the question, because no political trickery must be allowed around the ideal institution.

In the year 1880 the private bequests to all schools and colleges amounted to about $5,500,000; and, although there was one bequest of $1,250,000, yet the amount does not appear to be phenomenal. It would thus seem that the total amount was about five million dollars in one year, of which more than half is given to so-called colleges and universities. It would be very difficult to regulate these bequests so that they might be concentrated sufficiently to produce an immediate result. But the figures show that generosity is a prominent feature of the American people, and that the needs of the country only have to be appreciated to have the funds forthcoming. We must make the need of research and of pure science felt in the country. We must live such lives of pure devotion to our science, that all shall see that we ask for money, not that we may live in indolent ease at the expense of charity, but that we may work for that which has advanced and will advance the world more than any other subject, both intellectually and physically. We must live such lives as to neutralize the influence of those who in high places have degraded their profession, or have given themselves over to ease, and do nothing for the science which they represent. Let us do what we can with the present means at our disposal. There is not one of us who is situated in the position best adapted to bring out all his powers, and to allow him to do most for his science. All have their difficulties, and I do not think that circumstances will ever radically change a man. If a man has the instinct of research in him, it will always show itself in some form. But circumstances may direct it into new paths, or may foster it so that what would otherwise have died as a bud now blossoms and ripens into the perfect fruit.

Americans have shown no lack of invention in small things; and the same spirit, when united to knowledge and love of science, becomes the spirit of research. The telegraph-operator, with his limited knowledge of electricity and its laws, naturally turns his attention to the improvement of the only electrical instrument he knows any thing about; and his researches would be confined to the limited sphere of his knowledge, and to the simple laws with which he is acquainted. But as his knowledge increases, and the field broadens before him, as he studies the mathematical theory of the subject, and the electro-magnetic theory of light loses the dim haze due to distance, and becomes his constant companion, the telegraph-instrument becomes to him a toy, and his effort to discover something new becomes research in pure science.

It is useless to attempt to advance science until one has mastered the science: he must step to the front before his blows can tell in the strife. Furthermore, I do not believe anybody can be thorough in any department of science, without wishing to advance it. In the study of what is known, in the reading of the scientific journals, and the discussions therein contained of the current scientific questions, one would obtain an impulse to work, even though it did not before exist. And the same spirit which prompted him to seek what was already known, would make him wish to know the unknown. And I may say that I never met a case of thorough knowledge in my own science, except in the case of well-known investigators. I have met men who talked well, and I have sometimes asked myself why they did not do something; but further knowledge of their character has shown me the superficiality of their knowledge. I am no longer a believer in men who could do something if they would, or would do something if they had a chance. They are impostors. If the true spirit is there, it will show itself in spite of circumstances.

As I remarked before, the investigator in pure science is usually a professor. He must teach as well as investigate. It is a question which has been discussed in late years, as to whether these two functions would better be combined in the same individual, or separated. It seems to be the opinion of most, that a certain amount of teaching is conducive, rather than otherwise, to the spirit of research. I myself think that this is true, and I should myself not like to give up my daily lecture. But one must not be overburdened. I suppose that the true solution, in many cases, would be found in the multiplication of assistants, not only for the work of teaching but of research. Some men are gifted with more ideas than they can work out with their own hands, and the world is losing much by not supplying them with extra hands. Life is short: old age comes quickly, and the amount one pair of hands can do is very limited. What sort of shop would that be, or what sort of factory, where one man had to do all the work with his own hands? It is a fact in nature, which no democracy can change, that men are *not* equal, — that some have brains, and some hands. And no idle talk about equality can ever subvert the order of the universe.

I know of no institution in this country where assistants are supplied to aid directly in research. Yet why should it not be so? And even the absence of assistant professors and assistants of all kinds, to aid in teaching, is very noticeable, and must be remedied before we can expect much.

There are many physical problems, especially those requiring exact measurements, which cannot be carried out by one man, and can only be successfully attacked by the most elaborate apparatus, and with a full corps of assistants. Such are Regnault's experiments on the fundamental laws of gases and vapors, made thirty or forty years ago by aid from the French government, and which are the standards to this day. Although these experiments were made with a view to the practical calculation of the steam-engine, yet they were carried out in such a broad spirit that they have been of the greatest theoretical use. Again, what would astronomy have done without the endowments of observatories? By their means, that science has become the most perfect of all branches of physics, as it should be from its simplicity. There is no doubt, in my mind, that similar institutions for other branches of physics, or, better, to include the whole of physics, would be equally successful. A large and perfectly equipped physical laboratory with its large revenues, its corps of professors and assistants, and its machine-shop for the construction of new apparatus, would be able to advance our science quite as much as endowed observatories have astronomy. But such a laboratory should not be founded rashly. The value will depend entirely on the physicist at its head, who has to devise the plan, and to start it into practical working. Such a man will always be rare, and cannot always be obtained. After one had been successfully started, others could follow; for imitation requires little brains.

One could not be certain of getting the proper man every time, but the means of appointment should be most carefully studied so as to secure a good average. There can be no doubt that the appointment should rest with a scientific body capable of judging the highest work of each candidate.

Should any popular element enter, the person chosen would be either of the literary-scientific order, or the dabbler on the outskirts who presents his small discoveries in the most theatrical manner. What is required is a man of depth, who has such an insight into physical science that he can tell when blows will best tell for its advancement.

Such a grand laboratory as I describe does not exist in the world, at present, for the study of physics. But no trouble has ever been found in obtaining means to endow astronomical science. Everybody can appreciate, to some extent, the value of an observatory; as astronomy is the simplest of scientific subjects, and has very quickly reached a position where elaborate instruments and costly computations are necessary to further advance. The whole domain of physics is so wide that workers have hitherto found enough to do. But it cannot always be so, and the time has even now arrived when such a grand laboratory should be founded. Shall our country take the lead in this matter, or shall we wait for foreign countries to go before? They will be built in the future, but when and how is the question.

Several institutions are now putting up laboratories for physics. They are mostly for teaching, and we can expect only a comparatively small amount of work from most of them. But they show progress; and, if the progress be as quick in this direction as in others, we should be able to see a great change before the end of our lives.

As stated before, men are influenced by the sympathy of those with whom they come in contact. It is impossible to immediately change public opinion in our favor; and, indeed, we must always seek to lead it, and not be guided by it. For pure science is the pioneer who must not hover about cities and civilized countries, but must strike into unknown forests, and climb the hitherto inaccessible mountains which lead to and command a view of the promised land, — the land which science promises us in the future; which shall not only flow with milk and honey, but shall give us a better and more glorious idea of this wonderful universe. We must create a public opinion in our favor, but it need not at first be the general public. We must be contented to stand aside, and see the honors of the world for a time given to our inferiors; and must be better contented with the approval of our own consciences, and of the very few who are capable of judging our work, than of the whole world beside. Let us look to the other physicists, not in our own town, not in our own country, but in the whole world, for the words of praise which are to encourage us, or the words of blame which are to stimulate us to renewed effort. For what to us is the praise of the ignorant? Let us join together in the bonds of our scientific societies, and encourage each other, as we are now doing, in the pursuit of our favorite study; knowing that the world will some time recognize our services, and knowing, also, that we constitute the most important element in human progress.

But danger is also near, even in our societies. When the average tone of the society is low, when the highest honors are given to the mediocre, when third-class men are held up as examples, and when trifling inventions are magnified into scientific discoveries, then the influence of such societies is prejudicial. A young scientist attending the meetings of such a society soon gets perverted ideas. To his mind, a mole-hill is a mountain, and the mountain a molehill. The small inventor or the local celebrity rises to a greater height, in his mind, than the great leader of science in some foreign land. He gauges himself by the molehill, and is satisfied with his stature; not knowing that he is but an atom in comparison with the mountain, until, perhaps, in old age, when it is too late. But, if the size of the mountain had been seen at first, the young scientist would at least have been stimulated in his endeavor to grow.

We cannot all be men of genius; but we can, at least, point them out to those around us. We may not be able to benefit science much ourselves; but we can have high ideals on the subject, and instil them into those with whom we come in contact. For the good of ourselves, for the good of our country, for the good to the world, it is incumbent on us to form a true estimate of the worth and standing of persons and things, and to set before our own minds all that is great and good and noble, all that is most important for scientific advance, above the mean and low and unimportant.

It is very often said, that a man has a right to his opinion. This might be true for a man on a desert island, whose error would influence only himself. But when he opens his lips to instruct others, or even when he signifies his opinions by his daily life, then he is directly responsible for all his errors of judgment or fact. He has no right to think a molehill as big as a mountain, nor to teach it, any more than he has to think the world flat, and teach that it is so. The facts and laws of our science have *not* equal importance, neither have the men who cultivate the science achieved equal results. One thing is greater than another, and we have no right to neglect the order. Thus shall our minds be guided aright, and our efforts be toward that which is the highest.

Then shall we see that no physicist of the first class has ever existed in this country, that we must look to other countries for our leaders in that subject, and that the few excellent workers in our country must receive many accessions from without before they can constitute an American science, or do their share in the world's work.

But let me return to the subject of scientific societies. Here American science has its hardest problem to contend with. There are very many local societies dignified by high-sounding names, each having its local celebrity, to whom the privilege of describing some crab with an extra claw, which he found in his morning ramble, is inestimable. And there are some academies of science, situated at our seats of learning, which are doing good work in their locality. But distances are so great that it is difficult to collect men together at any one point. The American association, which we are now attending, is not a scientific academy, and does not profess to be more than a gathering of all who are interested in science, to read papers and enjoy social intercourse. The National academy of sciences contains eminent men from the whole country, but then it is only for the purpose of advising the government freely on scientific matters. It has no building, it has no library; and it publishes nothing except the information which it freely gives to the government, which does nothing for it in return. It has not had much effect directly on American science; but the liberality of the government in the way of scientific expeditions, publications, etc., is at least partly due to its influence, and in this way it has done much good. But it in no way takes the place of the great Royal society, or the great academies of science at Paris, Berlin, Vienna, St. Petersburgh, Munich, and, indeed, all the European capitals and large cities. These, by their publications, give to the young student, as well as the more advanced physicist, models of all that is considered excellent; and to become a member is one of the highest honors to which he can aspire, while to write a memoir which the academy considers worthy to be published in its transactions excites each one to his highest effort.

The American academy of sciences in Boston is perhaps our nearest representation of this class of academies, but its limitation of membership to the State deprives it of its national character.

But there is another matter which influences the growth of our science.

As it is necessary for us still to look abroad for our highest inspiration in pure science, and as science is not an affair of one town or one country, but of the whole world, it becomes us all to read the current journals of science and the great transactions of foreign societies, as well as those of our own countries. These great transactions and journals should be in the library of every institution of learning in the country, where science is taught. How can teachers and professors be expected to know what has been discovered in the past, or is being discovered now, if these are not provided? Has any institution a right to mentally starve the teachers whom it employs, or the students who come to it? There can be but one answer to this; and an institution calling itself a university, and not having the current scientific journals upon its table or the transactions of societies upon its library-shelves, is certainly not doing its best to cultivate all that is best in this world.

We call this a free country, and yet it is the only one where there is a direct tax upon the pursuit of science. The low state of pure science in our country may possibly be attributed to the youth of the country; but a direct tax, to prevent the growth of our country in that subject, cannot be looked upon as other than a deep disgrace. I refer to the duty upon foreign books and periodicals. In our science, no books above elementary ones have ever been published, or are likely to be published, in this country; and yet every teacher in physics must have them, not only in the college library, but on his own shelves, and must pay the government of this country to allow him to use a portion of his small salary to buy that which is to do good to the whole country. All freedom of intercourse which is necessary to foster our growing science is thus broken off; and that which might, in time, relieve our country of its mediocrity, is nipped in the bud by our government, which is most liberal when appealed to directly on scientific subjects.

One would think that books in foreign languages might be admitted free; but to please the half-dozen or so workmen who reprint German books, not scientific, our free intercourse with that country is cut off. Our scientific associations and societies must make themselves heard in this matter, and show those in authority how the matter stands.

In conclusion, let me say once more, that I do not believe that our country is to remain long in its present position. The science of physics, in whose applications our country glories, is to arise among us, and make us respected by the nations of the world. Such a prophecy may seem rash with regard to a nation which does not yet do enough physical work to support a physical journal. But we know the speed with which we advance in this country: we see cities springing up in a night, and other wonders performed at an unprecedented rate. And now we see physical laboratories being built, we see a great demand for thoroughly trained physicists, who have not shirked their mathematics, both as professors and in so-called practical life; and perhaps we have the feeling, common to all true Americans, that our country is going forward to a glorious future, when we shall lead the world in the strife for intellectual prizes as we now do in the strife for wealth.

But if this is to be so, we must not aim low. The problems of the universe cannot be solved without labor: they cannot be attacked without the proper intellectual as well as physical tools; and no physicist need expect to go far without his mathematics. No one expects a horse to win in a great and long race who has not been properly trained; and it would be folly to attempt to win with one, however pure his blood and high his pedigree, without it. The problems we solve are more difficult than any race: the highest intellect cannot hope to succeed without proper preparation. The great prizes are reserved for the greatest efforts of the greatest intellects, who have kept their mental eye bright and flesh hard by constant exercise. Apparatus can be bought with money, talents may come to us at birth; but our mental tools, our mathematics, our experimental ability, our knowledge of what others have done before us, all have to be obtained by work. The time is almost past, even in our own country, when third-rate men can find a place as teachers, because they are unfit for every thing else. We wish to see brains and learning, combined with energy and immense working-power, in the professor's chair; but, above all, we wish to see that high and chivalrous spirit which causes one to pursue his idea in spite of all difficulties, to work at the problems of nature with the approval of his own conscience, and not of men before him. Let him fit himself for the struggle with all the weapons which mathematics and the experience of those gone before him can furnish, and let him enter the arena with the fixed and stern purpose to conquer. Let him not be contented to stand back with the crowd of mediocrity, but let him press forward for a front place in the strife.

The whole universe is before us to study. The greatest labor of the greatest minds has only given us a few pearls; and yet the limitless ocean, with its hidden depths filled with diamonds and precious stones, is before us. The problem of the universe is yet unsolved, and the mystery involved in one single atom yet eludes us. The field of research only opens wider and wider as we advance, and our minds are lost in wonder and astonishment at the grandeur and beauty unfolded before us. Shall we help in this grand work, or not? Shall our country do its share, or shall it still live in the almshouse of the world?

PAPERS READ BEFORE SECTION B.

Determination of the relation between the imperial yard and the metre of the archives.

BY WILLIAM A. ROGERS OF CAMBRIDGE, MASS.

THIS paper was a continuation of one upon the same subject presented at the Montreal meeting. The mean result of the determinations up to that time was as follows: Imperial yard + 3.37015 inches = Metre des archives.

The writer stated at that time, that he should not like to be held to a very strict account with regard to the last decimal figure, or even the last two decimal figures, on account of the difficulty of obtaining the requisite data.

Since the meeting last year, additional data have been obtained. In February of the present year, a combined yard and metre was received from Paris. The yard was compared with the imperial yard, in 1880, by Mr. Chaney, the warden of the imperial standards. During the interval between 1880 and February of the present year, this metre has received repeated comparisons with the metre of the International bureau, under the direction of Dr. Pernet. According to his report, this metre is 310 mikrons too short at 0° centigrade; for the same temperature, the yard was found by Mr. Chaney to be 20.7 mikrons too short.

Comparing the metre and the yard upon this bar with the bronze yard and metre described at Montreal, and combining the results with those previously found, the relation was found as follows: Imperial yard + 3.37039 inches = Metre des archives.

The magnetophone, or the modification of the magnetic field by the rotation of a perforated metallic disk.[1]

BY PROF. H. S. CARHART OF EVANSTON, ILL.

THE experiments of Bell, Preece, and others, on the radiaphone, suggested the possibility of interrupting, or at least periodically modifying, the lines of force proceeding from the poles of a magnet, by means of a disk of sheet-iron, perforated with a series of equidistant holes, and rotated so that the holes should pass directly in front of the magnetic pole. It is well known that the armature placed on the poles of a permanent magnet diminishes the strength of the external field of force by furnishing superior facilities for the formation of polarized chains of particles from pole to pole. This is the case even when the armature does not touch the poles, but is in close proximity to them.

If a piece of sheet-iron be placed over the poles of a magnet without touching, and magnetic curves be developed on paper above the iron, they will be found to exhibit less intense and less sharply defined magnetic action than when the sheet-iron is removed. If, however, a small hole be drilled directly over each magnetic pole, the screening action of the sheet-iron is modified in much the same way as when a hole is

[1] This paper will shortly be published in SCIENCE in full.

made in a screen opaque to light; for the developed curves show distinctly the outline of the holes. If, therefore, the sheet-iron in the form of a circular plate, pierced with a number of holes, be rapidly rotated between the poles of a magnet and small induction bobbins, the action of the magnet on the core of the bobbins will be periodically modified, because of the passing holes: and hence induced currents will flow through a circuit including the bobbin. A disk of sheet iron was pierced with two circles of quarter-inch holes concentric with the disk, the number of holes in the two circles being thirty-two and sixty-four respectively. On one side of the disk was placed a horseshoe magnet with its poles very near the rows of holes; on the other side were arranged two corresponding induction bobbins. The circuit was completed through a telephone and either bobbin at pleasure. Upon rotating the disk rapidly, a clear musical sound was produced in the telephone, the pitch rising with the rapidity of rotation. Moreover, the bobbin opposite the circle of sixty-four holes gave the octave above the other, and each gave a note of the same pitch as was produced by blowing a stream of air through the corresponding holes.

Magnetic survey of Missouri.

BY F. E. NIPHER OF ST. LOUIS, MO.

In the spring of 1878 a survey of Missouri was begun, which was expected to determine all points in regard to terrestrial magnetism: 160 points have been covered. The work was undertaken under private auspices, most of the money tendered unasked, and the work has been carried on successfully until the present time. The first three years were spent in making a preliminary survey. In the early part of the survey we labored under great difficulties, because I supposed that the lines of equal value, laid down upon the observations given in the coast-survey charts, were substantially correct; so that time was frequently lost in repeating values at stations left behind, in order to be certain that no error had been committed. But when we settled down to the conclusion that we really knew nothing about the matter, we had very much less trouble. At first, intensity determinations were made at each station; but in later years, since the magnets have proved so satisfactory, the plan was adopted of making absolute determinations only at regular intervals during the summer. The temperature corrections for the magnet were made twice, — once in 1878, and once two years ago, — and they agreed very closely with each other.

The dip circle was a large one, such as was formerly much used, and which was found to be an excellent instrument, though rather clumsy to carry. The charts which have been prepared show what the results were. In a former communication to the association at Cincinnati, I suggested an explanation of the peculiar flexures of the isogonic lines, as being due to earth-currents which seemed to be deflected by the moist river-valleys. The map upon which that hypothesis was based represented observations taken over the entire state. By re-determination we have found that those observations were all correct; but more detailed work shows that this explanation is not admissible. There is no explanation of the fact that contour has any thing to do with the deviation of the needle from the normal values. Similar flexures are also seen in the lines of equal inclination and the lines of intensity. One and perhaps two years will be required to accomplish the work properly. There is nothing new in the subject, except the rather unexpected flexures which we found in these lines. It shows very clearly that the isogonic lines which are published for the use of surveyors are of no earthly use. Work ought to be done in a detailed way over the whole country; and I hope we shall some time be able to combine with these determinations a series of magnetic values at ten or twelve different stations in the state of Missouri, and also simultaneous determinations of earth-currents upon lines making angles with each other at the different stations. Similar variations would probably be found in the states of Illinois and Iowa.

In the discussion which followed, President Rowland said, that with respect to the earth-currents, he himself never saw any experiments which gave steady earth-currents. Earth-currents are usually supposed to vary very quickly. They do not pass in a steady direction anywhere; and therefore he would inquire whether Professor Nipher has any reason to suppose there are such earth-currents, and, further, whether these local changes of these lines may not be due to hidden mines of iron, or something or other, rather than to earth-currents.

The question was also asked, whether, in comparing earlier observations with the later, there are variations from year to year which would soon invalidate any survey that could be made, and render it comparatively of no value.

I suppose, replied Professor Nipher, that, over rather large areas of country, the annual change does not vary very rapidly in space. In the western states, so far as I know at present, it is pretty nearly constant, though I do not know as we have any reason to say that it is really constant. Replying to the president's last question, I should say that the determination to which I have referred, as regards earth-currents, was not for the purpose of testing the theory which I formerly had, but simply for the purpose of examining a cause which certainly has some effect. I think it is well enough known that it is a fact, and it is well to investigate it, since we found so many unexpected things. I should suppose that the explanation, that it is due to magnetic matter under the surface of the earth, is the much more probable one, as the case stands now. As to the disposition of that magnetic matter, you can make a great variety out of that, and locate your mines in various parts of the state.

Prof. A. E. Dolbear inquired whether any investigations have been made as to the direction of earth-currents; and whether Professor Nipher knew of any device which would enable him to detect the direction of them in any place. He had made some observations on a line of his own, half a mile long, and had invariably found that in that line the current is in one direction; and its electro-motive force varies from about one-tenth of a volt up to three volts.

In regard to these lines, said President Rowland, quick flexures of that sort must be due to local causes. They cannot be due to any thing at the centre of the earth. With respect to using a line in determining earth-currents, I think it is unsatisfactory. I do not believe very much in it, myself. You can get a current in the line, but you are not certain it is in the earth.

A member remarked that in 1881, in Boone County, Missouri, he had a line in which a continuous current was evinced with an electro-motive force of from two to four volts. From 8 to 10 in the morning was the maximum, and 5 P.M. the minimum. The line being east and west, the direction of the current was from east to west.

President Rowland said: If you put the wire on the earth's surface from one point to another, you merely determine the difference of intensity between those points. It shows there is a current there when the wire is there, but not when the wire is not there.

A method of distributing weather forecasts by means of railways.

BY T. C. MENDENHALL OF COLUMBUS, OHIO.

THIS system has only been in operation in Ohio for about a year. To distribute forecasts, we place signals upon the sides of the baggage-cars, as distinct as possible from each other, so as to be easily recognized at considerable distances, and also to convey as much meaning as possible, so as to predict as many different conditions. We adopted a combination of form and color. The signals are three in number as to form, and two in number as to color. The red signals are confined to predictions as to temperature, — rise in temperature, stationary temperature, falling temperature. The other color is blue, and that is confined to predictions in regard to the general state of the weather. The question of form was a good deal considered, and three forms were adopted. We adopted the sun, moon, and star, because everybody was familiar with those words. We experimented with the triangle, and finally rejected it. The device for attaching to the car is due to Mr. Anderson, who has been in the service of the board of commissioners for the past year; and it is a really happy device. The signal is made as large as possible, and the disk can be seen a long distance. The red sun and blue moon mean higher temperature and general rain. The crescent means lower temperature; the full disk of blue means general rain; the star represents local rains. With regard to the proper working of the system, though it has been in operation but a short time, it has really done good work. We receive special telegrams every morning, and they are transmitted to the train-despatchers at five o'clock. We are as yet operating it only on one railroad. It happens, fortunately, that that road goes through an agricultural region of considerable importance. It is the road connecting the cities of Columbus and Cleveland. Two trains start out in the morning, at the middle point between those cities. The signals are put on the cars at five o'clock in the morning; and as they run through the morning hours, the farmers along the line can have an opportunity of seeing them, and predicting the weather for the day. The railway company circulated through the whole line little cards, having these signals displayed in colors, with their meaning in every combination. This helps us, because it enables everybody to understand what is meant. A recent communication from Gen. Hazen indicates a disposition on the part of the general government to take hold of the matter, and bring it into general operation as far as possible. Postal-cards have been sent to various persons along the line, with questions in regard to the practical working of the system, which are answered and sent in at the end of every week; and we find, that, on the average, 80 per cent of the predictions are verified.

Plan for a state weather service.

BY F. E. NIPHER OF ST. LOUIS, MO.

WHILE a good many are accommodated by the weather-signals which Professor Mendenhall has already inaugurated, many live a distance from the railroad, and cannot be interested in a scheme which makes it necessary to travel eight or ten miles to learn about the weather, because they might be interested in a different kind of weather by the time they got home. The information might be most easily circulated by telegraphing from picket-stations to the westward. There might be a line of stations on the railroad north and south; and stations might be found necessary in Nebraska, which would give immediate warning to the central office whenever it began to rain at the station; and a code might be arranged, so as to give the idea of the operator as to the probable violence or duration of the rain. Of course it would be necessary to make special study of the general laws for the progress of summer rains. Supposing the information is telegraphed to the central station, the predictions can easily be made out as soon as the picket-stations could be reached, and a clear idea obtained as to the probable direction of the storm, and the time at which it would reach the different portions of the state. That information could be transmitted by the railway companies. Finally, we should make more intimate connection between these and private telegraph-lines which can be constructed by the persons who are to be served with the weather-signals. This plan contemplates the erection of private telegraph-lines leading in from the country to the stations. Upon a twenty-mile line, which would be a frequent length in Missouri, ten farmers will have to pay for the erection of a couple of miles of wire, and the instruments, which can be put up for $30 a mile. Some person could be sent from the vicinity to the director of the service, and instructions given him in regard to the manner of operating the line and the management of the batteries. The cost of the line, therefore, to each farmer, would be, say, $75, which might be distributed over ten years. Mr. Nipher stated that in several localities the farmers will undertake it just as soon as the information can be furnished them. At the stations the lines could easily be made to terminate in the store of some merchant, who is anxious to secure the trade of the people on the line. This can be done at once in Missouri. The only thing necessary is for the state to appropriate a small amount of money to supply the persons and instruments for observations, rain-gauges, etc. The two things necessary to make it successful are information as to rainfall, and time of beginning and ending of rains.

NOTES AND NEWS.

— The next meeting of the American association for the advancement of science will be held in Philadelphia, probably during the first week in September, 1884. At the session in Minneapolis last Tuesday, the following persons were chosen as officers for the Philadelphia meeting: President: Dr. J. P. Lesley, of Philadelphia. Vice-presidents: Section A (mathematics and astronomy), Prof. H. T. Eddy, of Cincinnati; B (physics), Professor John Trowbridge, of Cambridge; C (chemistry), Prof. J. W. Langley, of Ann Arbor; D (mechanical science), Prof. R. H. Thurston, of Hoboken; E (geology and geography), Prof. N. H. Winchell, of Minneapolis; F (biology), Prof. E. D. Cope, of Philadelphia; G (histology and microscopy), Prof. T. G. Wormley, of Philadelphia; H (anthropology), Prof. E. S. Morse, of Salem; I (economic science and statistics), Hon. John Eaton, of Washington. Permanent secretary: Mr. F. W. Putnam, of Cambridge. General secretary: Dr. Alfred Springer, of Cincinnati. Assistant general secretary: Prof. E. S. Holden, of Madison. Secretaries of the sections: A, Mr. G. W. Hough, of Chicago; B, Mr. N. D. C. Hodges, of Salem; C, Prof. R. B. Warder, of Cincinnati; D, Prof. J. B. Webb, of Ithaca; E, Prof. E. A. Smith, of Tuscaloosa; F, Prof. C. E. Bessey, of Ames; G, Dr. Romyn Hitchcock, of New York; H, Mr. W. H. Holmes, of Washington; I, Mr. Charles W. Smiley, of Washington. Treasurer: Hon. William Lilly, of Mauch Chunk.

— A course of eighteen special lectures will be given next year to members of Johns Hopkins university on topics relating to instruction in the higher institutions of learning. They will be informal lectures, connected only by the general purpose of helping advanced students who are looking forward more or less definitely to the work of teachers to become familiar with the principles and methods followed by other persons, and with the results which have been obtained in different types of educational establishments. The following are announced: —

The present state of university and collegiate instruction in this country, by D. C. Gilman; Recent observations on educational foundations in Europe, by D. C. Gilman; Natural and ethnic history of arithmetic, by J. J. Sylvester; The educational value of grammar, by B. L. Gildersleeve; The future sphere of classical philology, by B. L Gildersleeve; Educational value of the study of chemistry, by Ira Remsen; What to teach in biology, by H. Newell Martin; One lecture by H. A. Rowland; The observational element in mathematics, by C. S. Peirce; The *a priori* element in physics, by C. S. Peirce; The *naïve* in education, by H. Wood; Modern methods in the study of history, by H. B. Adams; Methods of comparative philology as pursued to-day, by M. Bloomfield; The new impetus given to the study of Latin by the application of the historical method, and by the study of inscriptions, by Minton Warren; Hygiene in collegiate training, by E. M. Hartwell; Rhythm and education, by G. Stanley Hall; The educational value of specialization and original work, by G. Stanley Hall; The uses of libraries in education, by D. C. Gilman.

A course of nine lectures specially designed for college students will also be given, as follows: —

The choice of a profession, by D. C. Gilman; The light which biography throws on college life, by D. C. Gilman; Reading as an auxiliary to study, by W. Hand Browne; The right use of translations, by C. D. Morris; Historical fiction, by H. B. Adams; The English universities, by J. Rendel Harris; Recreation, by E. M. Hartwell; Mental hygiene, by G. Stanley Hall; Science work, by Ira Remsen.

— The Imperial meteorological observatory of Japan has established a telegraphic weather-service, and at present receives reports from twenty-two well-distributed stations. No forecasts are yet attempted, although it is the intention to make them as soon as sufficient experience will justify the step. Tri-daily maps and bulletins are, however, prepared. It is interesting to note that but one telegram is received each day from the several stations. This is sent by the aid of a cipher, which consists of a simple combination of figures, not of words, as is the case in the cipher used by the U. S. signal-service. The daily despatch is the equivalent of about eight words, and contains all the usual meteorological data for each of the three preceding observations.

— The Meteorological council publishes the results of rainfall observations at three hundred and thirty-six stations in Great Britain, made without interruption from 1866 to 1880, under the supervision of Mr. G. J. Symons. The monthly means are given for each year, for each period of five years, and for the whole fifteen years. No discussion of the observations is made, though it would seem that valuable conclusions could be derived from them.

— Mr. V. T. Chambers, an entomologist well known for his studies on the Tineina, died at his residence in Covington, Ky., at two o'clock on the morning of Aug. 7. During the afternoon of Aug 6 he had a stroke of paralysis, and died from its effects. He was fifty-two years old on that morning. He was a constant contributor to the *Canadian entomologist* and many other entomological journals. In the Bulletin of the U. S. geological survey there are several papers from his pen: viz., the Tineina of Colorado; notes on a collection of tineid moths made in Colorado in 1875 by A. S. Packard, jun.; on the distribution of Tineina in Colorado; new Entomostraca from Colorado; descriptions of new Tineina from Texas, etc.; Tineina and their food-plants; and an index to the described Tineina of the United States and Canada. He also contributed a number of papers to the *Journal* of the Cincinnati society of natural history, of which he was a member, and at one time president. The most important of these papers were: on the tongue (*lingua*) of some Hymenoptera; on Pronuba yuccasella Riley, and the habits of some Tineina; his annual address as president of the society on the metamorphoses of insects, as illustrated in the tineid genus Lithocolletis of Zeller; descriptions of some new Tineina, with notes on a few old species; illustrations of the neuration of the wings of American Tineina; and on the antennae and trophi of lepidopterous larvae. Many of these papers are illustrated by his own drawings. A lawyer by profession, he found time to do much excellent work in science, and formed a large collection, which has been for some years in the Museum of comparative zoölogy at Cambridge. He was also proficient as a microscopist and a botanist. He leaves a wife and three sons, and his loss will also be felt by all the entomologists of the country.

— Dr. John A. Warder, for many years one of the most prominent horticulturists and foresters in the west, died at his home at North Bend, O., on July 14, in the seventy-second year of his age. He has been identified with the west, and especially with Cincinnati, for nearly fifty years. He was president for many years of the Horticultural society, and has written many papers on botanical and kindred subjects. He was one of the founders of the American forestry association, always took an active interest in its proceedings, and contributed many papers to its meetings.

— Professor Simon Newcomb has taken passage for home in the Bothnia, which sails to-morrow from Liverpool to New York. He was to attend the meeting of the French association for the advancement of science at Rouen, just closed. Prof. E. C. Pickering, who has been spending the summer in Europe, will return in October.

— "At the end of May," says Dr. G. Hinrichs in his July Iowa weather bulletin, "this year's growing season, counted from April 1, was sixty degrees in the aggregate ahead of last year's. We had gained nothing more at the end of June; for last year's June was moderate, the same as this season's June. But during July we gained in the aggregate one hundred degrees over last year's July; so that, on the 1st of August of this year, we have received in the aggregate one hundred and sixty degrees of heat more than last year at this period. This fact, together with the fair sky and generally favorable distribution of rainfall, accounts for the greatly superior condition of our crops this year.

"The storm-record," he adds, "has been given in sufficient detail to help to dispel the exaggerated notions of danger from whirlwinds in Iowa. It will readily be seen, that if squalls extending simultaneously over a large storm-front, and progressing for hours like a huge wave, are heralded as 'tornadoes' at every place they reach, people at a distance will soon wonder that towns exist at all in the north-west, and our own people will be scared into expensive tornado insurance. In time our buildings will be substantial enough to withstand our summer squalls and winter blizzards successfully. As to genuine tornadoes, they are rare, and very limited in extent."

— For some months the electricians of Paris have held a monthly dinner. These dinners owed their origin to Count Hallez-d'Arros, and were attended by no organized society, but were re-unions of those interested in electrical science. Lately it has been thought better to give the gatherings more stability by some manner of permanent organization; and at the June meeting a *Société des électriciens* was formed.

— During the past year, original investigations in the following subjects, among others, have been carried on in the physical laboratory of Johns Hopkins university under the direction of Professor Rowland and Dr. Hastings: on the photography of the spectrum by means of the concave grating (the photographs of the spectrum, so far made, extend down to B, the original negatives being about $\frac{3}{4}$ the scale of Angström's map from B to b, equal to Angström's from b to G, and $1\frac{1}{2}$ Angström's from G to the extreme ultra-violet; they show 150 lines between the H lines, and give the 1474 and b_3 and b_4 widely double and the E line indistinctly double); on the determination of the B. A. unit of electrical resistance in absolute measure; the determination of the specific resistance of mercury; the variation of the specific heat of water with the temperature; the relative wave-lengths of the lines of the spectrum by means of the concave grating; the effect of difference of phase in the harmonics on the timbre of sound; and on the variation of the magnetic permeability of nickel by change of temperature.

— Professor Palmieri announces the existence in the lava of Vesuvius of a substance giving the spectrum line of 'helium,' — an element hitherto recognized only in the sun. He considers the late disaster at Ischia to be due to subsidence of land consequent on the unusual activity of Mount Vesuvius.

— There will shortly be published by Allen & Co. of London a book by A. H. Swinton, entitled 'The influence of the sun on natural phenomena.' One may judge of the book's value by the following quotation from the prospectus: "The multitude who read the morning's newspaper may find in it some reason for their successes and losses, further than blind fatality."

RECENT BOOKS AND PAMPHLETS.

Cogniaux, A. Petite flore de Belgique à l'usage des écoles. Mons, *Manceaux*, 1883. 232 p. 12°.

Cock, A. de. Flora der Dendervallei. Analytische sleutel der familien en geslachten (zaadplanten af phanerogamen). Gand, *Meyer-Van Loo*, 1883. 108 p. 8°.

Dandois de Mellet. Du rôle des organismes inférieurs daos les complications des plaies. Bruxelles, 1883. 332 p. 8°.

SCIENCE.

FRIDAY, AUGUST 31, 1883.

SONNET.

The years through which aught that hath life, O Sun!
Hath watched or felt thy rising, what are they
To those vast aeons, when, from night to day,
From dawn to dark, thy circuit thou didst run,
With none to greet thee or regret thee; none
To bless thy glowing harbinger of cloud,
Rose-tinted; none to sigh, when, like a shroud,
The banner of Night proclaimed her victory won?

Yet through that reign of seeming death, so long
To our imperfect ken, the marvellous force
Which means to ends adjusts in Nature's plan
Was bringing to the birth that eye of man
Which now, O Sun, surveys thy farthest course,—
A speck amid the countless starry throng.

John Reade.

NOTES ON THE GEOLOGY OF THE TROAD.

A brief summary of the results derived from the observations made in connection with the Assos expedition.

The terranes of the Troadic peninsula comprise a variety of stratified and massive or eruptive rocks. The former, excepting the most recent deposits, which are not considered in this connection, may be divided into three groups, according to their mineralogical conditions and geological age.

The most ancient group is highly crystallized, and, in all probability, belongs to the mica-schist zone of the 'grundgebirge' or archean formation.

The youngest group, embracing the miocene and pliocene tertiary deposits, is, in part at least, well characterized by its fossils. The middle group is not defined, excepting by the widely separated limits of the other two groups. It embraces rocks which may be paleozoic or pre-paleozoic, as well as others which are probably of cretaceous and eocene age.

The crystalline schists have their greatest development in Mount Ida, of which they form almost the entire mass. They are of many varieties, all conformably interstratified, as if all belonged to the same great terrane.

True gneisses are not abundant, and occur chiefly upon the north side of Mount Ida, under such conditions that they appear to overlie the schistose rocks. In Hagi ouldòuren-dagh the mica is in large part replaced by hornblende, so that the gneiss has a somewhat dioritic aspect.

In the schistose rocks, chiefly amphibolites, hornblende is one of the most widely distributed and abundant minerals. It generally appears as actinolite, and not infrequently constitutes almost the whole of the rock in which it occurs. With amphibole, at times, are associated, besides plagioclase, more or less quartz, epidote, magnetite, titanite, and rutile. True mica-schists are of less common occurrence interstratified with the amphibolites.

Near the centre of Mount Ida, the oldest rocks crop out; and among them are talc-schists, which, by the gradual addition of olivine, pass into small lens-shaped masses composed almost exclusively of the latter mineral. According to the nomenclature of Brogger, this rock should be called olivine-schist. By alteration it gives rise to serpentine with the characteristic reticulated structure which ever marks the serpentine derived from olivine. Occasionally the fibrous serpentine forms veins of considerable size in the adjacent rocks.

The olivine-schist, where purest, has no schistose structure. The passage from talc-schist, in which no olivine occurs, to that composed almost completely of olivine, takes place sometimes within a short distance. The chief mass of the rock, however, is a middle stage between the two extremes, having a distinct schistose structure, and composed for the most part of olivine and talc, besides considerable quantities of pyroxene, as well as other minerals not yet determined. At various intervals throughout the zone of schistose rocks, occur rather coarsely crystalline white limestones.

The structure of Mount Ida is a comparatively simple anticlinal, with so short an axis extending east and west that the upper portion of the mountain is approximately a dome.

The highly crystalline stratified rocks are perhaps the chief topographical determinants of that region. Their position and distribution indicate, that, in the early stages of its development, the peninsula of the Troad was represented by several islands, which furnished much of the detritus for subsequent formations.

The rocks of the middle zone are for the most part semi-crystalline limestones, a very ferruginous quartzite, together with greenish, somewhat schistose rocks, and others which are macroscopically like argillites, but contain too large a proportion of quartz. The limestone is generally compact, gray or reddish colored, very like the cretaceous (according to Professor Neumayr) in the acropolis at Athens, and has often large quantities of silica so irregularly accumulated as to produce a very rough weathered surface like the cretaceous limestone west of Smyrna. This limestone is found chiefly about the base of Mount Ida, at Edremit, Qojikia-dagh, and Chaly-dagh, as well as between Qayalar and Ahmadja, and several kilometres south-west of Ilisfagy. At Qojikia-dagh it is peculiar in containing many small needle-shaped quartz crystals. The ferruginous quartzite was observed only upon the acute summit of Dikili-dagh.

The greenish, somewhat schistose rocks, with sandstones of the same color, near Ahmadja, as west of Smyrna, overlie the limestone. The cretaceous age of the limestone at the locality last named appears to be quite definitely determined by Strickland, Tchihatcheff, and Spratt; but the age of that near Ahmadja is yet uncertain. Only one fossil has been found in it. Concerning this, Professor Neumayr writes, "It is a Rhynconella which is so widely distributed that it cannot be used as a certain means of determining the age of the strata in which it occurs; but the limestone is probably cretaceous."

That these rocks are younger than those of the mica-schist zone is indicated, not only by the fact that they contain fossils, and are less crystalline than that group, but also by the fact that they are made up of sediments derived from the crystalline schists. On the other hand, that they are, at least in part, old rocks, is shown by the contact zone produced in them by the quartz diorite.

In 1881 Mr. Frank Calvert, American consul at Dardanelles, discovered undoubtedly eocene fossils (determined by Professor Neumayr) at several places in the Troadic peninsula outside of the region visited by the geologist of the expedition. The same rocks, in all probability, occur also in the southern Troad; but, until further investigations are made, their appearance must be left doubtful.

It seems probable, therefore, that in the intermediate zone there are a number of terranes of different age. It should be stated in this connection, that the rocks of the southern Troad, placed by Tchihatcheff provisionally in the lower tertiary, are, according to Professor Neumayr, of more recent origin.

The third or youngest group of stratified deposits, embracing those which are certainly not older than the miocene, may be divided into two portions. Geographically they are entirely distinct, and their stratigraphical relations are yet uncertain.

The rocks of the sarmatic stage (tufa) of the miocene, so well exposed at Eren-kieui, are now known to border the western coast from the Trojan plain to beyond the mouth of the Touzla, near the promontory of Baba-bournou.

At the site of ancient Hamaxitos, several kilometres south-west of Kinlahly, the 'mactra-kalk,' with its characteristic fossils, forms the acropolis. This limestone is undoubtedly of marine origin; and although it has a wide distribution north-eastward, toward the Caspian and the Vienna basin, yet it has not been recognized farther south-west than the coast of the Troad.

Beneath the limestone, as at Eren-kieui, is a great thickness of sand and clay beds which are underlaid by a conglomerate, and probably at the bottom of the series a stratum of red clay. The conglomerate is composed chiefly of fragments of andesite and liparite. Fossils have not been found in these beds near Hemaxitos; but at Eren-kieui, according to Calvert and Neumayr, organic remains are not infrequent, and of a mixed character, indicating that the strata belong, at least in great part, to the sarmatic stage. The marine beds which overlie the mactra limestone are largely developed south of the mouth of the Touzla, and contain great numbers of fossils, among which are many Ostrea and gastropods.

The second portion of the tertiary deposits occupies a large part of the interior of the Troad about the great plain of the Menderè, between Ezine and Bairamitch, as well as along the southern coast, west of Papazly. It has furnished but few fossils, and they are of such a character that its age cannot be determined with certainty. However, according to Professor Neumayr, who has kindly undertaken the determination of the fossils collected by the expedition, it must be upper miocene, miopliocene, or lower pliocene. That it is in great part a fresh, or at most a slightly brackish water deposit, cannot be doubted. As has already been shown in a preliminary report, where these deposits are described at some length, the basis of the series is a conglomerate in which fragments of the basalts, andesites, and liparites, have not been found. It is overlaid by a series of shales, upon which, between Demirdji-kieui and Narly, rests a puzzling rock, regarded by Tchihatcheff as limestone. It is usually pale-yellowish colored, soft, light, and porous, and generally shows no trace of effervescence in hydrochloric acid. In general appearance it closely resembles an impure siliceous limestone from which the greater portion of the carbonate of lime has been leached away. Having a thickness of about a hundred and thirty metres, it becomes the chief topographical determinant of that region, and gives rise to profound gorges and bold escarpments. Throughout the greater portion of the mass, it is uniformly fine-grained, but under the microscope has the structure of a tufa.

The upper beds of the series, consisting of thin fresh-water limestones, sandstones, shales, and a large proportion of stratified tufas, with conglomerates, have not been seen east of Demirdji-kiēui. The fossils collected were found in this portion of the series; and it is evident that the ejection of the andesites began before the deposition of those beds was completed.

Numerous oscillations of the land, as indicated by the varying character of the strata, must have occurred during the miocene and pliocene; and, in all probability, these were connected with the extrusion of the eruptive rocks so abundant in that region.

The massive rocks of the Troad belong in part to those of pre-tertiary origin, but the greater portion were extruded since the beginning of the tertiary period. The older group includes biotite-hornblende-granite, quartz-porphyry, quartz-diorite, augite-porphyrite, melaphyre, and serpentine, while the younger group embraces liparites, andesites, augite-andesites, basalts, and nepheline-basalt.

The biotite-hornblende-granite occurs in a stock-like mass, forming the serrated ridge of Chigri-dagh. It is distinctly younger than the highly crystalline stratified rocks which it penetrates, and is especially interesting from the fact, that, where it is altered, the titanite is changed to anatase. The alteration of titanite and ilmenite to anatase is doubtless a common and widely distributed occurrence; but, as the crystals of anatase are so small, they have generally been overlooked.

The quartz-porphyries are chiefly micrograntes. and are younger than the biotite-hornblende-granite through which they have been extruded. The dikes in which they occur are comparatively small, and do not exercise much influence upon the topographical features of the country.

The quartz-diorites form a number of comparatively small stöcke about the base of Mount Ida, and are evidently younger than the quartzose argillite of the middle zone of stratified rocks, which, in one case, has been metamorphosed into a cordierite and andalusite hornfels. It is to be especially noted that these eruptive rocks do not, as formerly supposed, enter into the structure of Mount Ida.

The augite-porphyrites (diabase-porphyrites) and melaphyres are, as far as yet known, limited to five outcrops, all lying in a line near the southern coast of the Troad, and, with the exception of that between Ahmadja and Qyalar, are not important. At the locality just named it is of especial interest from the fact that melaphyre was the first rock extruded in that isolated (completely surrounded by tertiary strata) volcanic centre, and was followed later by mica-andesite, hornblende-andesite, augite-andesite, basalt, and, late if not last, by a large outpouring of liparite.

The serpentine in the anterior part of the Troad about Qarâ-dagh has been derived from olivine-enstatite rocks of a truly eruptive nature. The almost entire absence of the characteristic reticulated structure in some of the serpentine from the Kemar valley leaves, perhaps, some doubt as to the original rock from which it has been derived. As previously stated, the serpentine about the summit of Mount Ida has been derived from olivine-schist which undoubtedly belongs to the stratified rocks.

Although the ancient eruptive rocks are apparently not nearly so abundant as those of more recent origin, yet they represent very nearly the same range in chemical and mineralogical composition. The granite and quartz porphyries have their modern equivalents in the liparites; the quartz-diorites, in the mica and hornblende andesites; the augite-porphyrites, in the augite-andesites; the melaphyre, in the basalt. However, no equivalents were found for the nepheline-basalts and the ancient olivine-enstatite rocks. On the other hand, the syenites, and their modern representatives the trachytes, which were once supposed to be abundant in the Troad, are now known to be at most only very sparingly represented.

The liparites occur in various types, with many varieties, and are limited to the southern part of the Troad. They appear also south of Molivo on the island of Mitylene, and at Sal Mosac south-west of Aivalÿ. They are generally in the stony condition, but frequently glassy upon the boundaries, and contain many fragments of the andesites which they have penetrated and overflowed. They always occur in dikes, as at Qozlou-dagh and the great plateau, which give rise to the peculiar drainage of the Touzla River. That some of the liparites were extruded before the deposition of the 'mactrakalk' is certain; but, from the fact that the exact age of the tertiary deposits in the southern part of the Troad has not been definitely determined, the time of the extrusion of the great mass of the liparites cannot be stated. However, it occurred most likely at the beginning or in the early part of the pliocene, when the land was raised above the sea, and the islands converted into a peninsula.

The andesites embrace typical mica-andesites and hornblende-andesites, as well as a great variety in which mica and hornblende occur in nearly equal proportion. These, with augite-andesite, occupy a great area between the Menderè and the southern coast; and, unlike the liparites, they seem to have reached the surface, at least in some cases, through volcanic vents. Not unfrequently they occur in dikes also, and have evidently overflowed a large area of late tertiary deposits.

Their extrusion along the western coast began before the deposition of the 'mactrakalk,' and along the southern coast during the formation of the fresh-water deposits of that region. Pyroxene is generally a prominent constituent of the andesites, and frequently both rhombic and monoclinic pyroxenes occur together. The former is generally the most abundant, and has in one case been proved to be hypersthene. It occurs not only in the mica-andesite at Assos and Smyrna, but also in the hornblende-andesite north-west of Qozlou-dagh, and the augite-andesite west of Sivriji-bournou. Among the great variety of andesites may be mentioned the oldest which flowed from the cràter at Assos. It is a mica-andesite, in the groundmass of which is a large proportion of apparently primary mica and hematite.

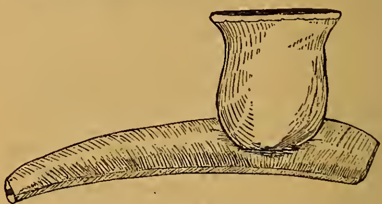
The basalts occur in dikes, and, although widely distributed, do not occupy large areas. Along the southern coast of the Troad it is of an andesitic type, and the olivine is occasionally altered to distinctly cleavable pleochroitic serpentine.

The same phenomenon is better developed in the typical nepheline-basalt which forms the prominent hill called Qaràlyly or Qapandjà-tepe, near the centre of the Troadic peninsula. The basalts and nepheline-basalt are evidently younger than the tertiary deposits with which they are associated; but the time of their extrusion with reference to that of the other eruptive rocks of the Troad cannot be definitely determined. J. S. Diller.

Greason, Cumberland County, Penn.,
June 4, 1883.

OCCURRENCE OF MOUND-BUILDERS' PIPES IN NEW JERSEY.

Until recently the one form of stone implement which is characteristic of the mounds of Ohio and westward, and that has not been duplicated in surface finds in New Jersey and elsewhere on our northern Atlantic sea-board, is the so-called mound-builders' pipes, such as were discovered in great numbers, and described in detail by Squier and Davis in the 'Ancient monuments of the Mississippi Valley,' and more recently by several authors. These pipes may be characterized as having a small bowl, usually in the shape of a bird, mammal, or human head, placed upon a short, flat, and slightly curved base, so perforated that it was used as the stem of the pipe. In other words, it was a complete smoking implement, and therefore unlike the ordinary pipes or pipe-bowls found in New Jersey and the New-England states, which, as a rule, required the addition of a stem of reed or hollow bone, to be used as the mouthpiece.



Within a few weeks, a pipe of the pattern I have described, assumed to be peculiar to the mound-builders, has been found in New Jersey. While the bowl is perfectly plain, except a slight scalloping of the rim, it will be seen at a glance, that the specimen is essentially of the same pattern as the 'animal pipes' found in Ohio, and recently also in Iowa.

Previous to 1882, I had been unable to find any pipes of this pattern, or traces of native copper implements of any kind; but since then copper spears, such as are found in Wisconsin, have been found in New Jersey, and now the pipe that I have described, and of which an illustration is given. Recently, also, specimens of flint arrow-heads have been collected, which in size, and delicacy of finish, are equal to the best examples from Oregon.

These specimens are now briefly referred to, as indicative of the fact, that in skill in working flint, and in the range of handiwork, whether in stone, bone, or clay, the difference between those people that erected the extensive earth-works of the Ohio valley and elsewhere, and the 'wild tribes' of the Atlantic seaboard, is practically nothing. I still hope to find unmistakable artificial mounds in New Jersey; basing my expectation upon the fact, that natural hillocks or knolls were frequently used as places of burial, and were chosen as desirable sites for the erection of wigwams.

CHARLES C. ABBOTT, M.D.

THE IGLOO OF THE INNUIT.[1]—III.

THE only instrument used in the construction of the igloo is the snow-knife. Where the Innuits have intercourse with white men, they bar-

MODERN SNOW-KNIFE.

ter for cheese-knives or long-bladed butcher-knives, remove the double handle from the tang, and put on a single one about three times as long, which can be readily grasped by both hands. The old knives were made of reindeer-horn or from the shin-bone of the reindeer.

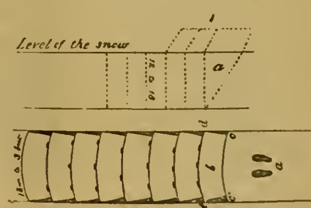
SNOW-KNIFE OF BONE.

Among the Esquimaux in and around King William's Land I found snow-knives made of copper stripped from Sir John Franklin's ships, the imprints of the queen's broad arrow still showing on many, the blades double-edged or dagger-shape, and the handles of musk-ox and reindeer horn rudely attached by sinew lashings.

The snow-knife of iron, while more convenient in many ways, is far more liable to break in the intense cold of the winter weather, such accidents with them being very common. I have seen igloos built when the thermometer registered −70° F. At such temperatures the snow becomes almost stone-like in its compactness. The snow-knife is often used as a substitute for the snow-tester whenever that instrument is broken or left behind, for the Esquimaux are a very careless and absent-minded people.

Before starting to cut the snow-blocks, the builder gets from the sledge a pair of gauntlets used for this purpose, only being of finer and softer reindeer-fur, so as to give the hands the most complete freedom of motion. These gloves extend half way up the fore-arm, and have a puckering-string around the top, which the builder's wife pulls tight, and ties so as to completely exclude the snow while he is at work in it.

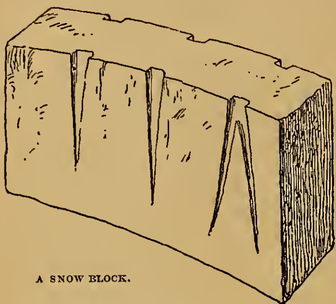
The igloo is built on the sloping drift of snow, the entrance being at the lowest point. The first trench from which the snow-blocks are cut is so disposed as to have its axis coincident with the diameter of the igloo, which runs directly up and down hill, or which makes the greatest angle with the horizontal. These snow-blocks are from a foot to a foot and a half wide, from a foot and a half to two or three feet long, and eight or ten inches thick. The first block cut from the trench is a thick triangular one, which is thrown away (see *a*, which is a vertical section through the axis of the trench). A ground plan of the blocks would show that they are partially curved, but in no manner to such an extent as would be needed to conform to the curvature of the igloo. This curvature is the result of their manner of cutting by a swinging motion of the whole body, held almost rigid, and rotating about the foot steps, *a*, in the figure. This motion of the whole body gives them considerable power; and the resulting curved blocks, if large, are in the best shape for the first part of the structure. In cutting the block *b*, first the right-hand edge, *cd*, is cut by three or four powerful downward strokes of the knife, and then the opposite edge, *c′d′*. The knife, with its blade held horizontally, is passed under the block in front of the toes of the builder's feet. About three or four inches in depth of the line *d′d* is cut; and,



with the knife in the right hand, two or three deep vertical thrusts are made along this line, which generally separate the snow-block from its bed, and it is caught with the left hand as it falls forward. I have tried to represent these gashes in the figure. They are plainly visible on the snow-block inside and out, and a good artist would represent them in his pictures of the huts. The blocks are carefully lifted out and placed beside the trench, as, under some circum-

[1] Continued from No. 29

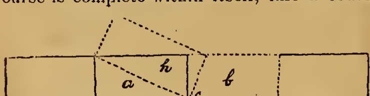
stances, they are extremely liable to break in handling. If the snow has been properly tested,



A SNOW BLOCK.

this should, however, seldom occur. The trench completed, and enough blocks secured to form the first or base course, the floor is laid out by a circular sweep of the knife, varying in diameter, of course, according to the number of intended occupants. Commencing at the left hand, this course is laid until the first block, *a*, is reached, which is cut in halves from its first lower corner, *c*, along the ascending diagonal; and the top half, *h*, is thrown away. The last block, *b*, has its contiguous corner cut off; so that the next block, shown in broken outline, ascends and forms the first block of the next course. The igloo is then formed of this spiral of snow-blocks, each course inclining inward slightly more than the one previous, until the last, which may be called the key-block, is perfectly horizontal, and firmly wedges in and binds the whole structure. This spiral form of the courses I have tried to show in the illustration of one of the half-completed igloos.

I know that the general idea is, that each course is complete within itself, like a course



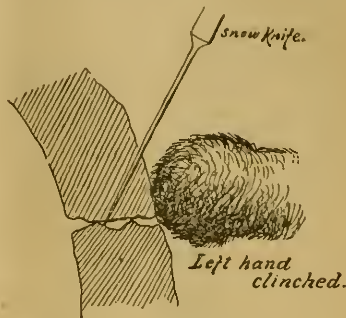
of bricks on a round tower in our method of building; but a moment's thought would show this to be almost impossible, as the first block in the course, after they had commenced to lean considerably, would have to be supported until it was flanked by others; and these, again, would be very unstable. In fact, one often wonders how a snow-block will hold in place against its own weight, leaning far inwards, almost horizontal, and supported only on two sides, and will imagine that the native workmanship must be very good to give such results. As the blocks approach the top, — where they are more nearly horizontal and more liable to tumble down, — their figure becomes trapezoidal in order to keep the vertical joints pointing to the centre and top; and, while supported on but two sides, these form a more or less acute angle, — more acute as it is needed and approaches the top, where the last few blocks are made triangular and meet at a point. The workman stands inside until it is completed. Despite all the care, the falling of

THE HALF-BUILT IGLOO.

blocks is a very common occurrence, and happens with nearly every building.

It will be remembered that the base course has been laid upon a sloping bank of snow, the lowest point being at the door, which has been formed by the trench running into the building. Therefore, when the builder is coming down with a course of blocks on the left side, they are peculiarly prone to tumble in. The fact that this side is used for starting up on the spiral course, as already explained, assists somewhat to overcome this; but it is mostly remedied by the builder, as each round is made, trimming down the up-hill part of the course to about half, until, by the time the blocks are leaning considerably, the course is level (leaving out the spiral inclination).

As each block is being fitted, it is held near its intended position by the left hand of the builder, who at one stroke cuts off the triangle on the right edge, giving a trapezoidal form. The left edge of the preceding block receives the same treatment, and the block is shoved into place. The snow-knife is rapidly passed backwards and forwards in the joints at the side and bottom, cutting off all inequalities, and making a fine powdery snow, which acts as a binding mortar. The last act is to give the block a sharp shoving blow with the open hand from the top, and another from the left side, which firmly sets it in place. The blocks all laid, the igloo is now complete, except the 'chinking' of the joints to render it air-tight, there being many large crevices. The chinking of an igloo is a very ingenious affair; the material being cut diagonally from the lower edge of the upper block on the horizontal joints, and from the left edge of the right block on the vertical ones, if the person be



VERTICAL CROSS-SECTION THROUGH WALL OF IGLOO.

right-handed. As the knife in the right hand thus trims the edges, the left fist, tightly clinched, follows the knife, and rams the cut portion tightly into the crevice, rendering it

THE FINISHING TOUCHES.

as perfectly air-tight as the body of the snow-block itself. An active Innuit will go completely around the igloo on a single joint in about a minute, and it seldom takes over ten to do all the chinking in a large hut. This part is generally assigned to the boys and women, especially the former, who are much lighter, as it is necessary to go on top to complete their work. A well-built igloo, however, will readily bear the weight of two large men on their hands and knees; and yet I have seen a small boy fall through one made of friable snow.

Meanwhile the boys and women have been busy throwing the loose snow from the trench-

THE SNOW-SHOVEL.

es, and piling it on the house, often following closely upon the work of block-laying, covering the whole to a depth of from six inches to half as many feet. The depth to which this is carried depends on the length of time they expect to use the hut, and on the temperature.

The common pictures of the huts, showing the block-work so conspicuously, are largely the work of the imagination of the artists, all that is seen being rounded heaps of rough granular snow. Such artistic license may, however, be allowable to show the essential features; and, so far as my criticism is concerned, I do not wish to be understood as saying that such uncovered igloos never occur.

I have spoken of the snow-walls, when chinked, as being perfectly air-tight. This is not strictly correct; the snow being more or less porous, and allowing a slow but ample current of air to pass through. In fact, at night the door is sealed, and the only means of ventilation is through the body of the snow.

In 1879, during a heavy north-east gale, I was in an igloo on the west bank of Back's River. The walls were of a granular snow, but were covered to a depth of three or four feet. Yet, with all this thickness, a candle-flame held near the wall on the windward side was deflected constantly at an angle of from thirty to thirty-five degrees from the vertical.

The banking is done with a snow-shovel made of half-inch boards, tapering off to a short handle for one hand: a bent piece of musk-ox horn fastened in at the centre furnishes a hold for the other. The cutting edge is protected by a sharpened shoe of reindeer-horn, neatly bound on with reindeer sinew, which is also used to sew the boards together. The Netschilluks use shovels of cedar, walnut, and mahogany from Franklin's ships.

(To be continued.)

MINNESOTA WEATHER.

Much has been said about the sanitary properties of the climate of Minnesota as a healing-place for the consumptive; and in this connection a great deal of erroneous information has been published, often to the serious injury of the invalid, who is misled by it. As might be expected, the newspaper is the principal agent in the dissemination of such literature. Here is an extract from the editorial page of the St. Paul and Minneapolis *Pioneer press*, the leading journal between Chicago and San Francisco: —

"Of the aid that may be given by a pure, rarefied, and dry atmosphere, thousands of people now living in Minnesota, who have been rescued from impending death, can bear substantial and grateful testimony."

Written in the haste of a newspaper office, by one who is practically pledged to the laudation of his state, as the western editor is, such a paragraph would scarcely deserve notice, were it not a summation in brief of some of the most popular errors afloat on this subject, and which one meets with everywhere in that land, from the drawing-room gossip to the medical journal. As such, it may profitably serve as text for analysis.

In the matter of pure air, Minnesota is not different from other northern states in which the face of nature has been moiled by the hand and habitation of man. On the prairies and in the pine-woods the atmosphere yet retains a large share of its pristine purity: in the cities it is the reverse. Especially is it vitiated in the large and rapidly growing cities of St. Paul and Minneapolis, whose systems of water-supply, drainage, garbage-removal, and sanitary inspection, cannot keep pace with their increase of population. This fault will be remedied in time, however, when the authorities shall have learned that the doubling or trebling of a city's people in a decade brings with it new responsibilities as well as new prosperity. It is an easy and pleasant thing to boast that one's town is gaining population at the rate of a thousand a month, and that the values of real estate are rising accordingly; but the real-estate owner is slow to appreciate the necessity of advancing the salaries of city officials, and the appropriations for city improvements, with corresponding alacrity. Minneapolis, although built upon the flat surface of the prairie, has admirable opportunities for drainage into the adjoining gorge of the Mississippi River; but its dilatoriness in this and other works of sanitary improvement has been severely punished by the scourge of typhoid-fever. The prevalence of this disease has caused Minneapolis at times to stand at the head of the column of death-rates of the cities of the United States. While there may be malaria in Minnesota, — and, indeed, the term is sometimes found in the reports of the physicians, — it is by no means the popular disease that it is in the south and east, where it is almost the fashion. A person may spend a year there without hearing the word mentioned; and that immunity alone should be enough to stimulate emigration in that direction.

Dryness of atmosphere is claimed for Minnesota; and if we consult only the amount of rainfall, whose annual value ranges from twenty to forty inches, there is apparent justice in this claim. But the manner as well as the amount of the pluvial precipitation must be considered. They have in that state a good deal of the lachrymose English weather, in which a drizzling dampness takes the place of the short, sharp, and decisive showers of equatorial lands. At the close of a rainy day the observer will go to his rain-gauge, and find its bottom scarcely covered. The effect of effort without accomplishment is always a depression of spirits in the looker-on; and this rule is never truer than when applied to a rainy day. Those who spent the month of October, 1881, in Minnesota, will remember it as a season of almost continual storm, during which, even when there was no absolute rainfall, there was an unwholesome mist floating in the air. Occasionally the sun shone, but not with sufficient power to make an impression. Farm-labor was almost suspended. The potatoes rotted in the ground, and the wheat grew in the stack. The streets of Venice were scarcely more liquid than the streets of St. Paul. Danger-signals were erected in the fashionable avenues to warn teamsters away from fathomless depths of mud. Hackney-coaches were stalled there, and their horses were detached, leaving the vehicles to be extracted by the processes of engineering. So impassable were the roads, that the fuel-supply was unequal to the demand, and invalids were obliged to go to bed to keep warm, and public schools were closed because their pupils were frozen out.

Still the rainfall of this month was less than four inches and a half. Many a single shower in the warm latitudes precipitates an equal amount of water. Indeed, there are records of rains in which as much water has fallen in one day as falls in Minnesota during the year; but, as a light rainfall does not necessarily mean a dry atmosphere, neither does an excessive precipitation invariably make a wet one. The water may flow away quickly, leaving no sign; and the next day the sun may shine as brightly as ever. Better, therefore, for the lungs, is an occasional drenching than a perpetual drizzle. While it must be admitted that the weather of the October just quoted, although not so bad as that of the September preceding, was yet exceptional in the extreme, still such exceptions could hardly occur in a very dry climate.

The student of physical geography would scarcely expect to find the climate of Minnesota a dry one. An average of such statistics as the writer has at hand indicates that rain or snow falls at least every third day in St. Paul. The state is almost directly under the influence of the Great Lakes, and is itself threaded with rivers, and dotted with lakes. Of the latter there are eight thousand worthy of the name, besides innumerable ponds. Two large river-systems receive their waters from the drainage of this region. The swamp-lands of the state play an important part in its area, as the maps of the land-office show. A large share of its forests are afloat upon ancient marshes. Cranberries and rheumatism abound. The Red River region is celebrated for its floods. At one time that stream was popularly said to be thirty miles wide; and the traveller down its valley was obliged to proceed by alternate stages of land and water, the steamboat being utilized when the railway-cars began to swim. Then it was that the facetious pilgrim from St. Paul to Winnipeg was, according to his habitual description of the journey, three days out of sight of land. It was a joke, to be sure; but such jokes are not heard in a dry climate.

The moisture of the atmosphere of Minnesota is the salvation of the state: it makes agriculture a possibility and a success. Given the same amount of rainfall in another latitude, and under more arid climatic conditions, and her wheat-fields would be blighted. As it is, her scanty rains, with the exception of a few showers in summer, fall slowly and gently; in times of drought the thirsty air freights itself with moisture from the abundant water-surface of the state; and these sources of humidity are re-enforced by the prolonged irrigation resulting from the melting of the winter snows and the thawing of the frozen ground in spring.

The beneficial effects of an unclouded sun in the treatment of consumption may, perhaps, be overrated. The dweller in a rainless atmosphere, dazzled by the perpetual brightness, and with lungs parched by the heat and dust and dryness of the air, might come at last to long for an occasional rainy day, as the traveller in the desert longs for the shadow of the palm. But, at any rate, our weather bureau could scarcely do better work than to give us a 'sunshine map,' upon which the statistics of hourly observations the year round, upon the state of the sky, should be graphically portrayed. Such frequent observations could be taken without inconvenience, as it would not be necessary for the observer to remain at a fixed station for that purpose. Such a map would show by depths of shading the relative amounts of sunshine and cloud at any place; and the invalid could select at a glance a residence which would have the desired proportion of these conditions. The complexion of Minnesota upon such a map would probably not vary widely from the average.

As has been seen, there is also a popular belief that the air of Minnesota is in a very rarefied condition. In the interests of meteorology, that superstition must be met and combated. The only cause of rarefaction of atmosphere worth considering here is elevation above the sea. Minnesota, as one might guess from its position in the Mississippi valley, is a low country. The mean elevation of the United States above sea-level is about twenty-five hundred feet. The average elevation of Minnesota is considerably less than half that number. Indeed, its 'height of land' falls much below twenty-five hundred feet. Therefore a large proportion of visitors to that state move into a heavier atmosphere than that which they have left; but unfortunately they do not know that fact, and, under the influence of their imaginations, they find their breath wonderfully shortened. The elevation of St. Paul above the sea is seven hundred or eight hundred feet; that of the plateau region of New York is from a thousand to two thousand feet. I once knew a lady to remove from the latter to the former place, thus going down hill and into a denser atmosphere. Arriving in St. Paul, she could with difficulty climb a flight of stairs, owing to the lightness of the air, as she expressed it. When informed of her mistake, she was indignant, and resented the information. People do not like to give up their errors, even if they are uncomfortable ones. Having come a thousand miles in search of novelty, it was strange and cruel if she could not be allowed to enjoy that novelty which is supposed to be characteristic of the west, — a rarefied atmosphere. With all its benefits, science works mankind an occasional mischief. The mountaineers of old suffered no inconvenience from their exalted position until the meteorologist came along, and explained to them that the air grew constantly thinner as they approached the clouds. Even to-day the unlearned inhabitants of our Rocky Mountain region make no complaints of a difficult respiration. It is only the scientific tourists who pant by the aneroid, and cough up a little blood when they cross the timber-line. Whether appreciated or not, however, it is certain that the air of the uplands is less substantial food for the lungs than that of the low countries; and it is the density of the atmosphere, and not the reverse, which is to the advantage of Minnesota as a home for the consumptive. There are many people who advise this unfortunate to seek out some elevated region in which to live, but there are very few who can give any reason for this counsel. A learned doctor tells us in one of the late magazines, that the harmful substance known as carbonic-acid gas is more abundant near the level of the sea. Certainly; since there is more air to the cubic measure at a low elevation, there is naturally more carbonic acid, which exists in the atmosphere, whether high or low, in a certain percentage of the whole; but there is at the same time more of the saving grace of oxygen, which the invalid is after. It is true that carbonic acid has a way of accumulating in low and unventilated recesses; but there are cellars, crevices, and deep and narrow valleys in the highlands as well as on the lower levels. As well recommend thin soup to the hungry man as to advise the sick man, whose one lung must do the duty of two, to breathe thin air. Should he climb the mountains to Leadville, he will be warned away by the inhabitants of that city, who will inform him, in the rude poetry of the mines, that a healthy man has to fan the air up into a corner in order to get enough for a breath.

The atmosphere is not necessarily dry at a great altitude, as some suppose, nor damp in the lowlands. There are lofty swamps and low deserts. The mountain peaks, according to the poet, milk the clouds; and in some parts of the world the mountaineer is more sure of his daily rain than of his daily bread. Mount Taylor, in New Mexico, is called the 'Mother of rain' by the imaginative Indians. On the other hand, the deserts of California, which are below the level of the sea, are so dry, that, in the language of the plains, the jack-rabbit has to pack his water with him when he goes upon a journey.

As to the thousands who have been rescued from death by the 'pure, rarefied, and dry atmosphere' of Minnesota, this is a matter of town talk, which impartial observation does not confirm, and which there is no census to deny. In this connection I would challenge the champion of the most celebrated sanitarium for consumptives to produce a list of the patients who have 'got better' under his notice, and I will match against him an equally honest observer from some undistinguished and unpretentious and confessedly unhealthy locality, whose proportional record of improvements will be equally favorable. Why, then, should the sick man become a wanderer, as he certainly will if he once starts in chase of the *ignis fatuus* of a climate cure?

Frank D. Y. Carpenter.

LETTERS TO THE EDITOR.

Prehensile feet of the crows.

In nos. 16, 18, and 20 of Science are communications by different writers on the intelligence of crows, suggested by one of mine in no. 13. I beg to add one more, concluding what I have to say on this subject.

All seem agreed as to the intelligence of these birds; but few, I find on inquiry, have seen them seize or carry objects in their claws. Yet no amount of negative testimony should invalidate my observation on the Italian bird, when taken in connection with the further evidence to be given. We all look at nature piecemeal; and it is certainly unreasonable to assume that one is in error because he claims to have seen through his pin-hole something which another has not observed through his.

I agree with the doubters, that crows ordinarily use their bills, and not their claws, in seizing and carrying their food. In confirmation of what I claim to have seen, I will adduce similar instances, noticed by others as well as myself, in the Corvidae. I cannot positively assert that the bird I saw was C. corone: it might have been C. cornix, possibly C. frugilegus, but, at any rate, a *crow*, for it had the flight, the proportions, the color, the voice, and the boldness of these birds.

As to crows not nesting among rocks, this is generally true of the American crow (C. Americanus); but the European C. corone, a larger and more solitary species, prefers the sides of steep rocks, as also does the hooded C. cornix. Both the American and European ravens often nest in inaccessible cliffs, and so do the rooks.

To begin with the largest. I have seen C. corax in Iceland holding and carrying in its claws fish-heads from the beaches, and, when disturbed, from one barren crag to another, — an object too large and too heavy to be conveniently carried in the bill, and too precious to be left behind where food is so scarce. I have seen C. carnivorus, in the winter wilderness of Lake Superior, carrying in the same way what looked like a squirrel or rabbit. It is well known that both these birds, when wounded, will strike savagely with their claws, like a bird of prey; which, being perching birds, according to our classifications they had no scientific right to do.

Of the fish-crow (C. ossifragus), Wilson (*Amer. ornith.*, v. 27) writes, "their favorite haunts being about the banks of the river, along which they usually sailed, dextrously snatching up *with their claws* [the italics are mine] dead fish or other garbage that floated on the surface;" and, on p. 28 (*op. cit.*), "These (a singular kind of lizard) the crow would frequently seize *with his claws*, as he flew along the surface, and retire to the summit of a dead tree to enjoy his repast." Audubon (*Orn. biog.*, ii. 269) says the same. Clark's Columbian crow is said to do the same thing, and its claws are sharp and raptorial. I have seen this species, along the shallows of the coast of North Carolina, seize and carry off in its *claws* living fish from the shoals over which it flew.

Buffon, Chenu, Wilson, and Nuttall allude to the custom of capturing crows by fastening one on its back, feet upward, on the ground: its cries bring its companions to the rescue, one of whom is sure to be seized and held by the *claws* of the prisoner.

For several summers I lived in the next house to a tame and speaking crow, which often came in front of the kitchen in quest of food. One day a half-eaten ear of boiled corn was thrown to him. While engaged in picking it, holding it by the claws, as is the habit with the crows, he was disturbed by the attacks of a barking terrier. Keeping him at bay for a time by vigorous pecks, he finally tried to carry the ear in his *bill* to a favorite perch in a low cedar. As he seized it, first at one end and then at another, the leverage of the free end was such that it gave his head and neck very uncomfortable twists. He finally perched upon the ear in defence of his food, and, clinching it tightly in his *claws*, flew with it, in my sight, to his perch a few feet distant.

Mr. E. A. Samuels (author of the 'Birds of New England') writes to me (Aug. 2, 1883), "I have known of its seizing with one foot — and hopping with the other — various small articles of food, in one case a small frog;" and also, "I have often seen the crow hold a frog or acorn firmly, with one foot on the ground or on a fence-rail, while he pecked away with his bill." Similar instances I remember to have read about, and one in the Bulletin of the Nuttall ornithological club, where it is described as holding a small bird, which it had killed in an aviary, in its claws, while it tore it in pieces with its bill, like a bird of prey.

The claws of the shrikes, weaker than those of the crows, and quite as insessorial, are used to seize and carry prey. A few winters ago I saw a shrike killed on the Boston public garden by the city forester's men, which had in its claws, during its flight, a still living English sparrow. That the crows in the above-mentioned instances, though perching birds, do use their claws as prehensile organs, I regard as evidence of their intelligence and reasoning power, which enable them, under exceptional circumstances, to use their perching feet for raptorial purposes. We must not measure animal intelligence by our imperfect and arbitrary zoölogical classifications. Since the writings of F. Cuvier, Flourens, and Fée, it seems impossible to deny the possession of a reasoning intelligence to animals below man.

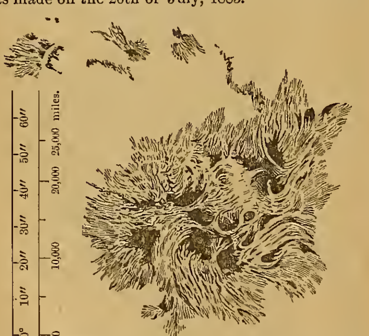
Leaving out of view the instance mentioned in no. 13, I think I have adduced sufficient evidence that the crows do *sometimes* — that is, when they find it necessary — seize and carry objects in their claws, like birds of prey. SAMUEL KNEELAND.

An interesting sun-spot.

The accompanying sketch represents the remarkable sun-spot of July (which was visible to the naked eye), and is of particular interest. I did not see it in its early or formative period, when this was taken; but from my knowledge of Mr. Very's experience and skill I have no doubt of the trustworthiness of the drawing in all its details. His remarks supply all the further information needed. S. P. LANGLEY.

Cambridge, Aug. 21, 1883.

I enclose a sketch of a large and unusually interesting sun-spot, as it appeared through the great equatorial of the Allegheny observatory, of 13 inches aperture, with the polarizing eye-piece. The drawing was made on the 26th of July, 1883.



The spot, while not so large as some, exhibited considerable activity and a remarkable assembly of odd forms, some of which appear so conflicting that it is difficult to imagine how they can exist side by side. The strong inrush from the following side gave one the idea of a viscid sheet or ribbon, rather than that of a bundle of filaments. It bore a striking resemblance to some of the forms which taffy assumes under the confectioner's manipulation. On the upper or northern side the filaments were more graceful, slender, and grass-like. The southern part was remarkable for the length and intensity of its curved filaments. (The longest could certainly be traced through more than 15,000 miles.) But perhaps the most curious portion was the centre, where a mass, possessed of photospheric brilliancy and fringed with curved and tangled threads, gave one the impression that a recently erupted facula, formed somehow in the very middle of the spot, was being torn to pieces by conflicting currents.

Numerous local whirls were evident, and the south-east half of the spot had a decidedly cyclonic appearance, the rotation being in an opposite direction to the hands of a watch. (It is to be remembered, that the drawing gives the appearance of a projection, and is therefore the reverse of a view by direct vision.) The north-west half of the spot did not show any such rotational tendency. F. W. VERY.

Allegheny, Aug. 20, 1883.

The right whale of the North Atlantic.

I am sufficiently impressed by the utter absurdity of occupying your valuable pages in discussing non-essentials; yet I am called upon by your critic to clear up two points remaining, both of which in any case hardly deserve serious notice. I will endeavor to close this correspondence by stating the facts.

Referring to Scoresby's pictures of the Greenland whale, I was led to attribute to the first or earlier one another authorship, from seeing in it so much error and exaggeration; and this because I had just read in Scoresby's book the following (Arct. reg., vol. i. p. 447. 1820): "I have confined my engravings, as well as my descriptions, to those animals that have come immediately under my own examination, or have been sketched by persons on whose accuracy and faithfulness I could fully depend; while drawings that I have met with, when the least doubtful, have been altogether rejected."

His second figure being so nearly correct, having evidently been carefully drawn from an entirely different and natural study of the animal, it was easy to assume, that, having first taken at second-hand an ill-considered sketch, he promptly replaced it by a better one. In this view it should not be assumed that we had any thing but the kindliest motives in thus speaking of this most eminent and valued man's work. In Scoresby's 'Arctic regions' (ed. 1820) the second figure of the Greenland whale appears. The caudal region, including the flukes, is entirely redrawn, showing the various elements that make up the beauty of those parts, as the carinae, etc. The other features, unfortunately, are not improved; yet more unfortunate is the fact that the earlier figure, with all its imperfections, has come down to us in most of the more important works.

With reference to the corrections of Scoresby's figures, we may point to an old work in the library of the American museum, which, by the way, is not noticed in Mr. Allen's bibliography; namely, "Histoire des pêches, des découvertes et des établissemens des Hollandois dans les mers du Nord, etc. Par Le C. Bernard DeReste. Tome premier. A Paris, 1801." This is an octavo volume, devoted almost entirely to cetaceans, and has large copperplate engravings, one of which contains a right whale labelled B. franche, and another the sperm whale.

The former figure is in some respects better than Scoresby's, as to form and proportions; but a most singular treatment has evidently been accorded it. The elements of the figure have been transposed, and the belly made to serve the purpose of back, and *vice versa*. It is evident that the figure was copied from a real model, as the baleen is shown correctly, though it projects in one place outside the mouth.

The remaining point relates to the authorship of the volume on whales in the 'Naturalists' library.' The portion of the titlepage of our edition relating to this point reads as follows: "Mammalia — whales, etc. By Robt. Hamilton, Esq., M.D., F.R.S.E., etc."

We now desire to ask our critic how much remains to justify the serious charges which he has caused to be distributed wide-cast over the scientific world, to more or less inevitable damage to institution and person. J. B. Holder.

If Dr. Holder is satisfied with the way he has met 'the serious charges,' I am quite willing to here rest the matter; failing, as I do, to see that any of them are materially vitiated by his defence, while, amid the obscurity of much irrelevant matter, all of the more important ones are virtually conceded.

In regard to the authorship of the volume on whales in the 'Naturalists' library,' not only have I, as I have said before, examined anonymous copies of the original edition, and found it given as anonymous in bibliographies, but have seen it attributed by contemporary British cetologists to Jardine. The discovery, however, of a copy by Dr. Holder, having Hamilton's name as author on the titlepage, of course settles the question. J. A. Allen.

Achenial hairs of Senecio.

Mr. Jos. F. James does not know of any explanation of the use of the threads which are projected from the hairs on the achenia of most species of Senecio, etc. Before calling on Science to help him, he might read up his text-books, say Gray's Structural botany, p. 306. Botanicus.

Kalmia or rhododendron.

In reply to Dr. Abbott, in Science for Aug. 17, I will call his attention to the fact that the woods of the kalmia and the rhododendron are quite distinct in appearance, and are not likely to be mistaken the one for the other. The kalmia wood is frequently found in commerce, in the form of handles for tools, such as chisels and the like. The wood is of a very light pink, with darker streaks through it resembling cells filled with woody fibre.

The rhododendron wood is destitute of such marking. As to size, I have seen plenty of the kalmia, four and five inches through the butt, in the mountains of Virginia; and have had in my possession sticks, large enough for any such purpose as the Doctor names, from eastern Pennsylvania. The rhododendron is an extremely rare plant in Chester and Delaware counties, Penn., but the kalmia is common. S. P. Sharples.

Boston, Aug. 22.

THE SOCIETY OF MECHANICAL ENGINEERS.

Transactions of the American society of mechanical engineers. Vol. iii. New York, 1882. 350 p. illustr. 8°.

This third volume of the transactions of the youngest of the three great societies of engineers in the United States is a well-printed large octavo of over three hundred pages. It contains a list of the officers and members of the society, its rules, the proceedings of the Philadelphia meeting of 1882, and the proceedings at a memorial session in remembrance of Dr. A. L. Holley, a distinguished engineer and a founder of the society. The proceedings at the latter meeting consisted of an introductory address by president R. H. Thurston, in eulogy of the deceased, and a formal tribute to his memory by Mr. J. C. Bayles, the orator appointed by a committee for the occasion. Many members, as well as the appointed orators, paid earnest and eloquent tribute to the great engineer.

Among the more generally interesting and important papers, are those of Professor Egleston, on the appointment of a government commission to test iron, steel, and other metals; G. W. Bond, on the Pratt & Whitney 'standard gauge system;' Professor Robinson, on the thermodynamics of the Worthington pumping-engine; an essay on the progress of engineering science from 1824 to 1882, by Mr. Fraley of the Franklin institute; the windmill as a prime motor, by Mr. Wolff; and a long paper on the several efficiencies of the steam-engine, by Professor R. H. Thurston.

Professor Egleston gives a history of a movement among the engineers and scientific and business men of the country, to secure the establishment of a permanent commission to determine, by direct investigation, the absolute and relative values of constructive materials in the United States. Under the lead of the Society of civil engineers, such a commission was demanded by a very large number of the leading men of the country, and was created by act of Congress in the year 1875. It consisted of Col. Laidley, Gen. Gilmore, Com. Beardslee, Chief-engineer Smith, Dr. A. L. Holley, and Professor Thurston, the latter acting as secretary. This commission, in the course of two years, working amidst many discouragements, did an enormous amount of work; the results of which are published in a report consisting of two large and fully illustrated volumes recently issued from the government press. The commission was not well sustained. Congress refused to continue its appropriations; and it ceased to exist, despite the protest of all the leading technical societies, polytechnic schools, the principal colleges, and such associations as that of the iron and steel makers. The effort is now making, to revive this commission, and to secure the continuance of its work. The publication of the enormous mass of information acquired by the board during the period of its short life is hoped to give good argument in favor of prompt and liberal action by another congress, in which, it is believed, there may be a sufficient number of intelligent and patriotic members to carry the measure through without regard to politics.

Mr. Bond describes the method adopted by Professor Rogers of Cambridge, and himself, to secure for Messrs. Pratt & Whitney of Hartford a standard system of exact measures for use in creating a basis for gauges to be used in the United States in general machine construction. The comparator built by the firm, under the advice of these gentlemen, is used. Its readings, with its 'B' microscope, are made from divisions measuring 0.000016 inches. The company has now a set of end measures running by sixteenths to four inches, and a complete plant for making them accurately to within the forty-thousandth of an inch, a magnitude which can be detected by an expert workman.

Professor Robinson gives the theory of the peculiar form of pumping-engine known as the Worthington engine. This is a Wolff form of compound engine in its general arrangement, built without fly-wheel and in pairs, and so constructed that each double engine has its valve-motion operated by the opposite machine. He shows that, theoretically, the 'tandem' type of this combination excels all the other possible adjustments of the engine, in its probable efficiency. The efficiency is not modified perceptibly by the ordinary slight variations of the exponent of the expansion curve. Numerical results of the use of the formulas are given in tabular form. The paper is illustrated by engravings of the several forms and parts of these engines.

Dr. Fraley describes the formation, the growth, and the work of the Franklin institute of the state of Pennsylvania. It was organized in 1824, and has been in active operation ever since. It established the first regular drawing-school in the United States, and has kept it in successful operation for fifty years. It has occasionally given exhibitions of domestic manufactures and products, has gathered together a great library, cabinets of materials, models, and machines, and has for many years regularly published a journal devoted to applied science and the arts.

Mr. Wolff gives the results of investigations of the efficiency and power of windmills, and presents a table, calculated in the course of his studies of the subject, of the relations between the pressure and the velocity of the wind at various temperatures, — the first in which the density and temperature of the atmosphere are taken into account.

Professor Thurston occupies nearly fifty pages in the discussion of the several efficiencies of the steam-engine, including the total commercial efficiency. Expressions are given by which to determine the best proportions of steam-boilers for given costs of boiler and fuel, storage, etc. The best area of heating surface per pound of fuel burned on the grate varies as the square root of the quotient of all annual expenses variable with the cost of fuel, reckoned per pound of coal and per square foot of grate, by the sum of all annual expenses per square foot of heating surface and per square foot of grate, the latter being reckoned only so far as they are dependent on the size of boiler. The efficiency of engine is found to be dependent upon both the ratio of expansion, and the method of variation of waste by internal cylinder condensation with the point of cut-off. Tables are given of the probable best points of cut-off in the various standard types of engines, at various pressures of steam; and also of the probable minimum weights of steam and of good coal required by such engines at various best ratios of expansion.

The 'efficiency of capital' is found to be dependent upon similar quantities, as well as upon the costs of fuel, attendance, operation, etc. The theory of the efficiencies of the ideal engine with non-conducting cylinder is given, and both algebraic and graphical methods of solving problems are presented and illustrated. The theory of the efficiencies of real engines is next treated, and the defects of the Rankine system are remedied. The 'general equation of all steam-engine efficiencies' is given, as deduced by Professor Thurston, and a series of problems falling under the general head are treated by the production of the necessary formulas and by a graphical construction involving the use of his newly discovered 'curve of efficiency.' One-half of the paper is devoted to the solution of various important problems arising in the practice of the engineer and previously unsolved. Tables follow giving the results as applicable to the common forms of steam-engine, and showing the enormous differences in economy and in the best ration of expansion, size of engine, etc., produced by the occurrence of cylinder condensation, a form of waste hitherto untreated by writers on thermodynamics and the theory of the steam-engine. He says, "By the use of this, or some more exact method, the art of proportioning the steam-engine can be elevated to the rank of a branch of the science of engineering; and that part of the science which has hitherto been in a most unsatisfactory condition, as viewed from the standpoint of the engineer engaged in its application, may be found to take a comparatively complete and useful form.''

GEOLOGY OF PHILADELPHIA.

The geology of Philadelphia: a lecture delivered before the Franklin institute, Jan. 12, 1883. By Professor Henry Carvill Lewis. Philadelphia, 1883. 21 p. 8°.

The author has distributed his pamphlet edition of this important paper, which deserves extended notice, and has placed him in the front rank of the young prosecutors of original research in the field of geology in this country. This memoir, and his previous lecture on the Ice age in Pennsylvania, have the rare merits that they are solid contributions to our knowledge from the first to the last pages; that they are almost exclusively due to the personal labors of the young geologist who brings them in their very complete form before the world; that they are closely and fairly reasoned out, and lucidly expressed. The great societies of the learned which require for membership the production of a work showing important, new, and original researches, have accepted many essays inferior in all these particulars to the subject of this review. To fully appreciate its merit, one must consider how very vague were the notions of geologists (including the large and growing class of Philadelphia geologists) as to our superficial deposits, before its appearance. The great influence of Louis Agassiz, and his theories of universal glaciation, had restricted the number of those who sought to define the action of glaciers in our continental geology, by extending the limits of this action over the tropics. The explanation of any thing obscure by the words 'glacial action' became almost as common as the explanation of any thing difficult in physiology used to be by the words 'lusus naturae.'

It required, therefore, peculiar independence of thought to break loose from these fictive (always the most insurmountable) fetters, and to see the phenomena with one's own eyes. Besides this, it required laborious journeys, patient note-taking, and attentive reading of what others had done, in order to do justice to the subject, and prepare a monograph upon it. All these Professor Lewis has accomplished; and, though much remains to be done, few presented so complete and neat a view of subject as he has.

It will already appear to be the writer's view, that his matter, and his manner of presenting it, have been found admirable, though as to the latter, his system, while supported by a clear style, will necessarily present some difficulties to the superficial reader. He could either have begun from the exterior and older boundaries of his superficial formations, and have proceeded inwards towards the present river Delaware; or he could have adopted his present plan of commencing in the middle with the red gravel, — inverting somewhat the order of the overlying sediments by considering the alluvium next (which is at the top of all), taking next the Trenton gravel (which underlies the latter), and completing the upper part of the column by treating of the Philadelphia brick clay (which belongs between the upland terrace material, first mentioned, and the Trenton gravel), — and then following the column downward through the red, yellow, and Bryn-Mawr gravels, finishing by a short sketch of the underlying rock formations; or he might have proceeded geographically from the newer deposits on the river, outwards to the Bryn-Mawr terrace.

The writer confesses, that, in view of the perfectly consistent theory which Professor Lewis has evolved, it would seem easier to follow the chronological order of the events which this theory comprehends, even though the geographical sequence were somewhat disturbed; but this criticism does not affect the real value of his results.

Those who read this essay as carefully as it deserves will be rewarded by obtaining a very probable history of this portion of our continent during post-tertiary time, with its submergences and elevations and the consequences thereof. It is perhaps to be regretted that Professor Lewis has not treated with the same care the subordinate part of his subject, to which he devotes a few concluding words; that is to say, the 'gneiss,' the 'auroral limestone,' and the 'triassic sandstone.' Thus, he confounds the views of two masters of our American geology in ascribing the gneiss of Philadelphia in the same breath to the Huronian and the Mont Alban.[1]

It is also somewhat vague to say 'the gneiss of the Rocky Mountains of Colorado;' since there are different gneisses belonging to different ages there, some of them probably Mont Alban, some Huronian, and some very likely Laurentian.

Again: it is conceded by most Philadelphia

[1] Compare Dr. T. Sterry Hunt's view, 2d geol. surv. of Penn., vol. E. p. 200.

geologists, that the section of gneiss along the left bank of the Schuylkill in the Park is not a fair representation of the stratigraphy of the measures. The structure here does not agree with that on the other side of the river for long distances within the limits of the Park, nor with that exposed by the cuts made for streets, etc., at short distances back from the river on this bank. Nor is it exact to say that the measures here dip 'at high angles;' since with the exception of a few hundred feet north of Lemon Hill, where one dip of 60° occurs, the dips for three miles are usually 30°, and never over 40°.

Under the caption of 'Primal sandstone,' it is the perpetuation of an error to call the 'sagging' of rocks standing at high angles '*creep*.' This term is employed by glacialists and mining engineers in two senses quite different from that which Professor Lewis intends to convey, and different from each other. Again: 'hydro-mica slates' is a contradiction in terms, though not infrequently used. If the rocks are *slates*, they cannot contain hydromicas, except as adventitious components. The last paragraph of this little pamphlet is very neat and well put; but we may be allowed to dissent from Professor Lewis in the statement that the marble of our doorsteps 'tells of an ocean inhabited by no fishes:' at least, mine does not tell me what were *not* in the ocean in which it was formed.

The blemishes in the main work are both few and superficial. Thus (p. 9), it is a little too hasty to infer, merely from the absence of shells or organic remains in a brick clay deposited on a gravel, that the water 'had a temperature too low to support life;' p. 11, the colors of the red and yellow gravels are not satisfactorily accounted for by the 'presence of a large body of water;' there is a slightly subjective trace in the assertion on the same page, that "there is no trace of glacial action in Pennsylvania south of the terminal moraine, *notwithstanding* all statements to the contrary hitherto made by other geologists," — which is in contrast with the modest style of other parts of the work; p. 14, 'Bryn Mawr age' is not a perfectly clear designation for the time or times when the gravels called by this name were being deposited, especially as there are crystalline rocks exposed at Bryn Mawr.

Notwithstanding these trivial faults (as the writer conceives them to be), the memoir will serve not only to teach our young students of geology to reason from these facts, but will live long, if not permanently, in our literature.

June 25, 1883. Persifor Frazer.

THE IROQUOIS BOOK OF RITES.

The Iroquois book of rites. Edited by Horatio Hale. Philadelphia, *Brinton*, 1883. (Brinton's Libr. Amer. lit., no ii.) 222 p. 8°.

Those who still hold in remembrance the valuable contributions to linguistics made by Mr. Horatio Hale while connected with the 'Wilkes exploring expedition' will be pleased to know that from his retirement in Canada he now sends forth this most interesting work. The reputation of the author, added to this fascinating title, will insure its favorable reception not only by ethnologists, but also the reading public. This aboriginal 'Iroquois Veda,' which furnishes the title, and which may be considered a remarkable discovery and indisputably of great ethnological value, is presented in its original Mohawk, with the English translation. An introduction of ten chapters precedes the Book of rites. These are devoted to the general history of the Iroquois, their league and its founders, condolence council, clans and classes, laws of the league, historical traditions, and their character, policy, and language. Portions of these chapters are deductions from the book which follows them.

The boundary-line between either folk-lore or myths, and actual history, is always so vague, that, even in the relation of facts, it is no easy task in their details to so discriminate as to keep truth clear from the brilliant coloring of tradition and conjecture. Especially is this the case when an author with inherited literary taste and vivid imagination enters a realm where the temptation to allow them full scope is as great as in the early history of the Iroquois. Accordingly, we find among these chapters, many of which indicate immense research and are of great value both ethnologically and philologically, those (such as the 'league and its founders') wherein the characters are portrayed in so exalted a manner that the sceptical reader will be disposed to assign the story of Hiawatha, as given in all its minute details, not to the realm of mythology even, but to that of classic historical romance. Much less will they be willing to accept it as sober Indian history five hundred years behind its present semi-civilized condition. The chapter on the 'Iroquois language' may be considered one of the most important, scientifically, of those in the introduction; and it is probably one of the best outlines of their formation and structure ever published in English, concerning any one of the Iroquois dialects. This fact quite throws the doubt on Mr. Hale's statement that no one except Father Cuoq would be competent to prepare a grammar of these dialects. With due respect for the great erudition of Father Cuoq, whose special studies have been in Algonquin, although a missionary to both tribes, we would say that the materials from which the reverend father prepared both his Lexique and the Iroquois portion of his Langues sauvages are through the courtesy of the Rev. Fathers Antoine and Burtin, of the order Oblat, now in the temporary possession of our Bureau of ethnology at Washington, where, already nearly translated, they will in time be published in connection with the other Iroquois dialects. We allude to the works of that greatest of all Mohawk scholars, the Rev. Father Marcoux. That the rules, the result of so much time and labor, can be clearly and distinctly presented to us in our own tongue, Mr. Hale has exemplified in the few which he presents in this chapter. The 'forms' and 'particles' which he has given are all from the Mohawk dialect, although he follows the example of all the Canadian authors, who dignify one dialect with the title which others contend belongs properly to a group. The examples he gives will many of them not apply to some of the other dialects, more especially to the Onondaga and Tuscarora.

In following too closely the rules of the French missionaries, great discrimination must naturally be exercised.

We do not agree, for example, with Mr. Hale, in the illustration given with his remarks upon the duplicative form, on p. 111.

The prefix of this form is *te;* the verb selected, *ikiaks,* — the same verb as given by Father Cuoq to illustrate this form.

I-kiăks, I cut, in the act of cutting; *te-kiaks*, I it cut in two, or divide; *hwisk* is the Mohawk numeral *five; hwisk té-kiăks*, I cut it into five pieces: hence *te*, the prefix, cannot be a synonyme of, or a literal translation of, the Latin *bi* in *bisecto* (I cut in two), but a sign that the act of cutting is or may be repeated as often as necessary.

Again, concerning gender (p. 106): the old French missionary idea of a 'noble' and 'ignoble' gender — the former of which included 'man and deities,' and the latter 'woman, evil spirits and objects' — is explained away very satisfactorily by Mr. Hale, until he admits with them the absence of any neuter form. This leads him into the error (p. 108) of following their form of conjugation.

The model containing the verbs 'to love' and 'to see' are as given originally by Father Marcoux, and presented to the public by Father Cuoq. Here the French form of conjugation is used, which lacks the neuter pronoun 'it,' but which is supplied with the indeterminate pronoun '*on*.' The neuter pronoun, however, does exist in these dialects as presented in five different chrestomathies already prepared.

The translation of the third person neuter (p. 108), *wat-kah-tos*, by 'she sees,' should be rendered by '*it* sees;' and the third person singular, translated as indeterminate 'one sees,' is, in fact, the third person feminine; and the same mistakes occur with the verb 'to love.'

These few exceptions are simply advanced to show how much study is yet to be given to these dialects, and that we cannot accept unreservedly the opinions of even the best acknowleged authority upon languages, which, we are learning, cannot be made amenable to the grammatical rules of any known tongue.

The author's opinions concerning clans are deserving of great attention; although many will be unwilling to agree with his conclusion, that, before the division of the Iroquois into tribes, there existed but the three presented in the Book of rites. It may be true that clans in some instances have been added, but we know of many more in our own day which have died out. The last male representative of the Rhut-kun-yah clan now occupies its chieftain's seat without a single constituent, upon the Tuscarora reservation, while among the same tribe the female remnants of the snipe clan have been passed over into that of the turtle. The examples of the added Onondaga and Oneida (p. 52) among the Iroquois of eastern Canada bear directly upon some remarks from a correspondent of Science in relation to the extra clans found among those Mohawks. This subject is referred to by our correspondent as 'an interesting field of inquiry.' Mr. Hale's remarks, while suggesting a clew, are not free from objections. The clans are not called by the above names. One is termed the 'calumet,' and has the pipe as its symbol, which it was the province of one chosen from this clan to present in solemn assemblies; and the chief of this clan also named the deputies, ambassadors, etc.: hence its title of '*Ro-te-sen-na-kéh-te*,' from which name Mr. Hale evidently christens it 'Onondaga,' whose council, not tribal name, is the same, signifying 'name-bearers.' The council name of the Cayuga tribe translates literally the 'great-pipe people' (p. 79): so might there not be as feasible a foundation for naming it the Cayuga clan? Moreover, would the same reasoning hold good concerning the rock clan, as the council name of the Oneida tribe differs on pp. 52 and 78? Before leaving this interesting subject, we would call attention to note 5 on p. 147: "It is deserving of notice, that the titles of clanship used in the language of ceremony are not derived from the ordinary names of the animals which give the clans their designations. *Okwaho* is 'wolf;' but a man of the wolf clan is called '*Tahionni*.'" The simple explanation is, that, in both the Seneca and Oneida, '*Tai-hyo-ni*' is the name of that animal. One might be tempted to theorize upon this; but so much is yet to be learned regarding this intermingling, retention, and coining of words, that for the present we have but to collate facts which can only be clearly explained or understood by a more full and complete comparison of the Iroquois dialects than has heretofore been obtainable.

The chapter entitled the 'Book of rites' explains its origin and character, the manner of its discovery by Mr. Hale, and the character of the Indians in whose possession it was found. That it is a genuine Indian production there can be no manner of doubt; and Mr. Hale's conclusions concerning its age are in all probability correct.

The Book of rites comprises the speeches, songs, and other ceremonies, which, from the earliest period of the confederacy, are supposed to have composed the proceedings of their council when a deceased chief was lamented, and his successor installed into office. The fundamental laws of the league, a list of their ancient towns, and the names of the chiefs who constituted their first council, all chanted in a kind of litany, are also comprised in the collection. These contents are said to have been preserved in the memory for many generations, and were written down by desire of the chiefs when their language was first reduced to writing. This manuscript, the original of which had been lost, Mr. Hale has, with the most competent Mohawk assistants, translated into English, and drawn from it most interesting conclusions regarding the character and policy of the Iroquois tribes, quite dissimilar from those generally accepted. The translation, notes, and glossary exhibit the work of a careful student. In the free translation rendered by Mr. Hale to the songs, he has given them a metre almost suggesting the peculiar melody, which, in the original Mohawk, was produced by intonations; for it must be remembered, that it is one orator who must untiringly continue to sing and chant, sometimes for twenty-four hours; and only by varying his key-note is he able to accomplish this feat.

A book which is as suggestive as this must bear good fruit. We have called the attention of our readers to many disputed points in the hope of awakening a spirit of inquiry upon subjects of such vital importance, many of which are here presented for the first time. We feel assured that the hopes of the author regarding it will be fully realized, and that students of history and of the science of man will here find new material of permanent interest and value.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The evidence for evolution in the history of the extinct Mammalia.[1]

BY E. D. COPE OF PHILADELPHIA.

The subject to which I wish to call your attention this morning requires neither preface nor apology, as it is one with the discussion of which you are perfectly familiar. My object in bringing it before the general session of the association was in view of the fact that you were all familiar with it in a general way, and that it probably interests the members of sections which do not pursue the special branch to which it refers, as well as those which do; also, since it has been brought before us in various public addresses for many years, during the meetings of this association, I thought it might be well to be introduced at this meeting of this association, in order that we might not omit to have all the sides of this interesting question presented.

The interests which are involved in it are large: they are chiefly, however, of a mental and metaphysical character; they do not refer so much to industrial and practical interests, nor do they involve questions of applied science. They involve, however, questions of opinion, questions of belief, questions which affect human happiness, I venture to say, even more than questions of applied science; certainly, which affect the happiness of the higher grades of men and women more than food or clothing, because they relate to the states of our mind, explaining as they do the reasons of our relations to our fellow-beings, and to all things by which we are surrounded, and the general system of the forces by which we are surrounded. So it has always appeared to me: hence I have selected the department of biology, and have taken a great interest in this aspect of it.

[1] A lecture given in general session, Aug. 20, 1883. Stenographically reported for Science.

The doctrine of evolution, as taught by the biologists of to-day, has several stages as grounds or parts of its presentation. First, the foundation principle is this: That the species of animals and of plants, the species of organic beings, as well as the various natural divisions into which these organic beings fall, have not always been as we see them to-day, but they have been produced by a process of change which has progressed from age to age through the influence of natural laws; that, therefore, the species which now exist are the descendants of other species which have existed heretofore, by the ordinary processes of reproduction; and that all the various structures of organic beings, which make them what they are, and which compel them to act as they now act, are the result of gradual or sudden modifications and changes during the periods of geologic time. That is the first phase or aspect which meets the naturalist or biologist.

Another phase of the question relates to the origin itself of that life which is supposed to inhabit or possess organic beings. There is an hypothesis of evolution which derives this life from no-life, which derives vitality from non-vitality. That is another branch of the subject, to which I cannot devote much attention to-day. There is still another department of the subject, which relates to the origin of mind, and which derives the mental organization of the higher animals, especially of man, from pre-existent types of mental organization. This gives us a genealogy of mind, a history of the production or creation of mind, as it is now presented in its more complex aspects as a function of the human brain. This aspect of the subject is, of course, interesting; and upon that I can touch with more confidence than upon the question of the origin of life.

Coming now to the question of the origin of structures, we have by this time accumulated a vast number of facts which have been collated by laborious and faithful workers, in many countries and during many years; so that we can speak with a good deal of confidence on this subject also. As to the phenomena which meet the student of zoölogy and botany at every turn, I would merely repeat, what every one knows, — and I beg pardon of my biological friends for telling them a few well-known truths, for there may be those present who are not in the biological section, — the phenomena which meet the student of biology come under two leading classes: the one is the remarkable fidelity of species in reproducing their like. 'Like produces like,' is the old theorem, and is true in a great many cases; just as coins are struck from the die, just as castings are turned out from a common mould. It is one of the most wonderful phenomena of nature, that such complex organisms, consisting of so many parts, should be repeated from age to age, and from generation to generation, with such surprising fidelity and precision. This fact is the first that strikes the student of these sciences. The general impression of the ordinary person would be, that these things must continue unchanged. When I began to study zoölogy and botany, I was remarkably surprised to find there was a science of which I had no conception, and that was this remarkable reproduction of types one after another in succession. After a man has had this idea thoroughly assimilated by his honest and conscientious studies, he will be again struck with another class of facts. He will find, not unfrequently, that this doctrine does not apply. He will find a series of facts which show that many individuals fail to coincide with their fellows precisely, the most remarkable variations and the most remarkable half-way attitudes and double-sided aspects occurring; and he will come to the conclusion, sooner or later, that like does not produce like with the same precision and fidelity with which he had supposed it did. So that we have these two classes of facts, — the one relating to, and expressing, the law of heredity; the other, which expresses the law of metamorphosis. I should not like to say which class of facts is the most numerously presented to the student. In the present fauna we find many groups of species and varieties before us; but how many species we have, how many genera we have, and families, we cannot definitely state. The more precise and exact a person is in his definition and in his analysis, the more definite his science becomes, and the more precise and scientific his work. It is a case of analysis and forms. What the scales are to the chemist and the physicist, the rule and measure are to the biologist. It is a question of dimension, it is a question of length and breadth and thickness, a question of curves, a question of crooked shapes or simple shapes, — rarely simple shapes, mostly crooked, generally bilateral. It requires that one should have a mechanical eye, and should have also something of an artistic eye, to appreciate these forms, to measure them, and to be able to compare and weigh them.

Now, when we come to arrange our shapes and our measurements, we find, as I said before, a certain number of identities, and a certain number of variations. This question of variation is so common and so remarkable, that it becomes perfectly evident to the specialist in each department, that like does not at all times produce like. It is perfectly clear, and I will venture the assertion that nearly all the biologists in this room will bear me witness, that variability is practically unlimited in its range, unlimited in the number of its examples, unlimited in the degree to which it extends. That is to say, the species vary by failing to retain certain characteristics, and generic and other characters are found to be absent or present in accordance with some law to be discussed farther on.

I believe that this is the simplest mode of stating and explaining the law of variation: that some forms acquire something which their parents do not possess; and that those which acquire something additional have to pass through more numerous stages than those which have not acquired so much had themselves passed through.

Of course we are met with the opposite side of the case, — this law of heredity. We are told that the facts there are not accounted for in that way; that we cannot pass from one class of facts to the other class of facts: what we find in one class is not applicable to the other. Here is a question of rational processes, of ordinary reason. If the rules of chemistry are true in America, I imagine they are true in Australia and Africa, although I have not been there to see. If the law of gravitation is effective here, I do not need to go to Australia or New Zealand to ascertain whether it is true there. So, if we find in a group of animals a law sufficient to account for their creation, it is not necessary to know that others of their relatives have gone through a similar process. I am willing to allow the ordinary practical law of induction, the practical law of inference, to carry me over these gaps, over these interruptions. And I state the case in that way, because this is just where some people differ from me, and that is just where I say the simple question of rationality comes in. I cannot believe that nature's laws are so dissimilar, so irregular, so inexact, that those which we can see and understand in one place are not true in another; and that the question of geological likelihood is similar to the question of geographical likelihood. If a given process is true in one of the geological periods, it is true in another; if it is true in one part of the world, it is true in another; because I find interruptions in the series here, it does not follow that there need be interruptions clear through from age to age. The assumption is on the side of that man who asserts that transitions have not taken place between forms which are now distinct.

We are told that we find no sort of evidence of that transition in past geological periods; we are assured that such changes have not taken place; we are even assured that no such sign of such transition from one species to another has ever been observed, — a most astonishing assertion to make *to* a biologist, or *by* a biologist; and such persons have even the temerity to cite special cases, as between the wolf and the dog. Many of our domestic dogs are nothing but wolves, which have been modified by the hand of man to a very slight extent indeed. Many dogs, in fact, nearly all dogs, are descendants of wild species of various countries, and are but slightly modified.

To take the question of the definition of species. Supposing we have several species well defined, say four or five. In the process of investigation we obtain a larger number of individuals, many of which betray characters which invalidate the definitions. It becomes necessary to unite the four or five species into one. And so, then, because our system requires that we shall have accurate definitions (the whole basis of the system is definitions: you know the very comprehension of the subject requires definitions), we throw them all together, because we cannot define all the various special forms as we did before, until we have but one species. And the critic of the view of evolution tells us, "I told you so! There is but one species, after all. There is no such thing as a connection between species: you never will find it." Now, how many discoveries of this kind will be necessary to convince the world that there are connections between species? How long are we to go on finding connecting links, and putting them together, as we have to do for the sake of the definition, and then be told that we have, nevertheless, no intermediate forms between species? The matter is too plain for further comment. We throw them together, simply because our definitions require it. If we knew all the known individuals which have lived, we should have no species, we should have no genera. That is all there is of it. It is simply a question of a universal accretion of material, and the collection of information. I do not believe that the well-defined groups will be found to run together, as we call it, in any one geological period, certainly in no one recent period. We recognize, however, that they diverge to a wonderful extent: one group has diverged at one period, and another one has become diversified in a different period; and so each one has its history, some beginning farther back than others, some reaching far back beyond the very beginning of the time when fossils could be preserved. I call attention to this view, because it is a very easy matter for us to use words for the purpose of confusing the mind; for, next to the power of language to express clear ideas, is its power of expressing no ideas at all. As we all know, we can *say* many things which we cannot *think*. It is a very easy thing to say twice two is equal to six, but it is impossible to think it.

I would cite what I mean by variations of species in one of its phases; I would just mention a genus of snakes, Ophibolus, which is found in the United States. If we take the species of this snake-genus as found in the Northern States, we have a good many species well defined. If we go to the Gulf States, and examine our material, we see we have certain other species well defined, and they are very nicely defined and distinguished. If, now, we go to the Pacific coast, to Arizona and New Mexico, we shall find another set of species well defined indeed. If we take all these different types of our specimens of different localities together, our species, as the Germans say, all tumble together: definitions disappear, and we have to recognize, out of the preliminary list of thirteen or fourteen, only four or five. That is simply a case of the kind of fact with which every biologist is perfectly familiar.

When we come to the history of the extinct forms of life, it is perfectly true, then, that we cannot observe the process of descent in actual operation, because, forsooth, fossils are necessarily dead. We cannot perceive any activities, because fossils have ceased to act. But if this doctrine be true, we should get the series, if there be such a thing; and we do, as a matter of fact, find longer or shorter series of structures, series of organisms proceeding from one thing into another form, which are exactly as they ought to be if this process of development by descent had taken place.

I am careful to say this; because it is literally true, as we all must admit, that the system must fall into some kind of order or other. You could not collect bottles, you could not collect old shoes, but you could make some kind of a serial order of them.

There are, no doubt, characters by which such and such shoes could be distinguished from other shoes, these bottles from other bottles; but it is also true, that we have, in recent forms of life in zoölogy and botany, irrefragable proofs of the metamorphoses, and transformations, and changes of the species, in accordance with the doctrine with which we commenced.

We now come to the second chapter of our subject. With the assumption, as I take it already satisfactorily proven, of species having changed over into others, in considering this matter of geological succession or biological succession, I bring you face to face with the nature and mode of the change; and hence we may get a glance, perhaps, at its laws.

I have on the board a sketch or table which represents the changes which took place in certain of the mammalia. I give you a summary of the kind of thing which we find in one of the branches of paleontology. I have here two figures, one representing a restoration, and the other an actual picture, of two extinct species that belong to the early eocene periods. One represents the ancestor of the horse line, Hyracotherium, which has four toes on his anterior feet, and three behind; and the other, a type of animal, Phenacodus, which antedated all the defined, or that a specific intermediate form of life will not be found. I think it is much safer to assert that such and such intermediate forms will be found. I have frequently had the pleasure of realizing anticipations of this kind. I have asserted that certain types would be found, and they have been found. You will see that I attend to the matter of time closely, because there have been a great many things discovered in the last ten or fifteen years in this department. In these forms I give the date of the discovery of the fauna in which they are embraced.

Here we have the White-River fauna discovered in 1856; then we skip a considerable period of time, and the next one was in 1869, when the cretaceous series was found. Six or seven cretaceous faunae have been found. Then we have the Bridger fauna in 1870, the Wasatch fauna in 1874. Next we have, in 1877, the Equus beds, and the fauna which they embrace, which also was found in 1878. The Permian fauna, which is one of the last, is 1879; and the last, the Puerco, which gives the oldest and ancestral types of the modern forms of mammalia, was only found in 1881. When I first commenced the study of this subject, about 1860, there were perhaps 250 species known. There are now something near 2,000, and we are augmenting them all the time. I have

Formation.	No. toes.	Feet.	Astragalus.	Carpus and tarsus.	Ulnoradius.	Superior molars.	Zygapophyses.	Brain.
Miocene . . Upper . . . . (Loup Fork.)	1-1 2-2 3-3 4-4 (5-5)	Digitigrade. (Plantigrade.)	Grooved. (Flat.)	Interlocking. (Opposite.)	Faceted.	4-tubercles, crested and cemented.	Doubly involute. Singly do.	Hemispheres larger, convoluted.
Middle . . . . (John Day.)	2-2 3-3 4-4	Digitigrade.	Grooved.	Interlocking.	Faceted. Smooth.	4-tubercles, and crested.	Singly involute. Doubly do.	Hemispheres larger, convoluted.
Lower . . . . (White River.)	3-3 4-3 4-4	Digitigrade. Plantigrade.	Grooved.	Interlocking.	Smooth. Faceted.	4 tubercles, and crested.	? Singly involute.	Hemispheres small; and larger.
Eocene . . Upper . . . . (Bridger.)	3-3 4-3 4-5 5-5	(Digitigrade.) Plantigrade.	Grooved. (Flat.)	Opposite. Interlocking.	Smooth.	4-tubercles. 3-tubercles, and crested.	Singly involute. Plane.	Hemispheres small.
Middle . . . . (Wasatch.)	4-3 4-5 5-5	Plantigrade. (Digitigrade.)	Flat. (Grooved)	Opposite. Interlocking.	Smooth.	4-tubercles. 3-tubercles, a few crested.	Plane. Singly involute.	Hemispheres small; mesencephalon sometimes exposed.
Lower . . . . (Puerco.)	5-5	Plantigrade.	Flat.	Opposite.	Smooth.	3-tubercles. (4-tubercles), none crested.	Plano.	Mesencephalon exposed; hemisphere small and smoother.

horse series, the elephant series, the hog, the rhinoceros, and all of the other series of hoofed animals. Each presents us with the primitive position in which they first come to our knowledge in the history of geological time.

I have also arranged here a series of some leading forms of the three principal epochs of the mesozoic times, and six of the leading ones of the tertiary time. I have added some da·s to show you the time when the faunae which are entombed in those beds were discovered, in the course of our studies; and you will easily see how unsafe it is to say that any given type of life has never existed, and assert that such and such a form is unknown; and it is still more unsafe, I think, to assert that any given form of life properly found many myself: if they were distributed through the days of the year, I think in some years I should have had several every day. But the accessions to knowledge which are constantly being made make it unsafe to indulge in any prophecies, that, because such and such things have not been found, therefore such and such things cannot be; for we find such and such things really have been and really are discovered.

The successive changes that we have in the mammalia have taken place in the feet, teeth, and brain, and the vertebral column. The parts which present us the greatest numbers of variations are those in which many parts are concerned, as in the limbs and feet. In the lower eocene (Puerco), the toes were

5–5. In the Loup-Fork fauna, some possess toes but 1–1. Prior to this period no such reduction was known, though in the Loup-Fork fauna a very few species were 5–5. Through this entire series we have transitions steady and constant, from 5–5, to 4–5, to 4–4, to 4–3, to 3–3, to 2–2, to 1–1. In the Puerco period there was not a single mammal of any kind which had a good ankle-joint; which had an ankle-joint constructed as ankle-joints ought to be, with tongue and groove. The model ankle-joint is a tongue-and-groove arrangement. In this period they were all perfectly flat. As time passes on we get them more and more grooved, until in the Loup-Fork fauna and the White-River fauna they are all grooved. In the sole of the foot, in the Puerco fauna, they are all flat; but in the Loup-Fork fauna the sole of the foot is in the air, and the toes only are applied to the ground, with the exception of the line of monkeys, in which the feet have not become erect on the toes, and the elephant, in which the feet are nearly flat also, and the line of bears, where they are also flat. As regards the ungulation between the small bones of the palm and of the sole, there is not a single instance in which the bones of the toes are locked in the lower eocene, as they are in the later and latest tertiary.

When we come to the limbs, the species of the Puerco fauna have short legs. They have gradually lengthened out, and in the late periods they are nearly all relatively long.

Coming to the vertebrae as a part of the osseous system, I will mention the zygapophyses, or antero-posterior direct processes, of which the posterior looks down, and the anterior looks up. They move on each other, and the vertebral column bends from side to side. In the lower forms of mammals they are always flat, and in the hoofed mammals of the Puerco period they are all flat. In the Wasatch period we get a single group in which the articulation, instead of being perfectly flat, comes to be rounded; in the later periods we get them very much rounded; and finally, in the latest forms, we get the double curve and the locking process in the vertebral column, which, as in the limb, secures the greatest strength with the greatest mobility. In the first stages of the growth of the spinal cord, it is a notochord, or a cylinder of cartilage or softer material. In later stages the bony deposit is made in its sheath until it is perfectly segmented.

Now, all the Permian land-animals, reptiles, and batrachians retain this notochord with the beginnings of osseous vertebrae, in a greater or less degree of complexity. There are some in South Africa, I believe, in which the ossification has come clear through the notochord; but they are few. This characteristic of the Permian appears almost alone, — perhaps absolutely alone as regards land-animals. There is something to be said as to the condition of that column from a mechanical standpoint, and it is this: that the cord exists, its osseous elements disposed about it; and in the batrachians related to the salamanders, and the frogs, these osseous elements are arranged under the sheath in the skin of the cord; and they are in the form of regular concave segments, very much like such segments as you will take from the skin of an orange, — parts of spheres, and having greater or less dimensions according to the group or species. Now, the point of divergence of these segments is on the side of the column. They are placed on the side of the column where the segments separate, — the upper segments rising and the lower segments coming downward. To the upper segments are attached the arches and their articulations, and the lower segments are like the segments of a sphere. If you take a flexible cylinder, and cover it with a more or less inflexible skin or sheath, and bend that cylinder sidewise, you of course will find that the fractures of that part of the surface will take place along the line of the shortest curve, which is on the side; and, as a matter of fact, you have breaks of very much the character of the segments of the Permian batrachia. It may not be so symmetrical as in the actual animal, for organic growth is symmetrical so far as not interfered with; for, when we have two forces, the one of growth and the other of change or alteration, and they contend, you will find in the organic being a quite symmetrical result. That is the universal rule. In the cylinder bending in this way, of course the shortest line of curve is right at the centre of the side of that cylinder, and the longest curve is of course at the summit and base, and the shortest curve will be the point of fracture. And that is exactly what I presume has happened in the case of the construction of the segments of the sheath of the vertebral column in the lateral motion of the animal swimming, always on one side, and which, at least, has been the actual cause of the disposition of the osseous material in its form. I have gone beyond the state of the discussion in calling attention to one of the forces which have probably produced this kind of result. That is the state of the vertebral column of many of the vertebrata of the Permian period.

I go back to the mammalia, and call attention to the teeth. The ordinary tooth of the higher type of the mammalia, whether hoofed or not, with some exceptions, is complex with crests or cusps. In cutting the complex grinding surfaces we find they have been derived by the infolding extensions of four original cusps or tubercles. They have been flattened, have been rendered oblique, have run together, have folded up, have become spiked, have descended deeply or have lifted themselves, so that we have teeth of all sorts and kinds, oftentimes very elegant, and sometimes very effective in mechanism. In many primary ungulates, the primitive condition of four conical tubercles is found. In passing to older periods we find the mammalia of the Puerco period, which never have more than three tubercles, with the exception of three or four species. In the succeeding periods, however, they get the fourth tubercle on the posterior side. Finally, you get a complicated series of grinding or cutting apparatus, as the case may be.

Last, but not least, we take the series of the brain. No doubt the generalization is true, that the primitive forms of mammalia had small brains with smooth hemispheres; later ones had larger brains with complex hemispheres. In general, the carnivora have retained a more simple form of brain, while herbivorous animals have retained a most complicated type of brain. The lowest forms of mammalia display the additional peculiarity of having the middle brain exposed; and the hemispheres or large lobes of the brain, which are supposed to be the seat of the mental phenomena, are so reduced in size at the back end that you see the middle brain distinctly, though it is smaller than in reptiles and fishes. It is beyond the possibility of controversy, that these series have existed, and that they have originated in simplicity, and have resulted in complication; and the further deduction must be drawn, that the process of succession has always been towards greater effectiveness of mechanical work. There are cases of degradation, as in the growing deficiency in dentition in man. There is no doubt that a large number of people are now losing their wisdom-teeth in both jaws.

We are now brought to the question of the relations which mind bears to these principles. The question as to the nature of mind is not so complex as it might seem. There is a great deal of it, to be sure; but on examination it resolves itself into a few ultimate forms. An analysis reduces it to a few principal types or departments, — the departments of the intelligence and of emotions (with their modified smaller forms, likes and dislikes), and the will, if such there be. Those three groups, proposed by Kant, are well known, and adopted by many metaphysicians; and they stand the scrutiny of modern science perfectly well in both men and the lower animals. But the question of the material of the mind, the original raw stuff out of which mind was made, is one which is claiming attention now from biologists, as it always has done from physiologists proper and physicians. This is sensibility, mere simple sensibility, unmodified sensibility or consciousness. Sensibility, in connection with memory, is sufficient for the accomplishment of wonderful results. It is only necessary to impress the sensibility with the stimuli which this world affords, whether from the outside or the inside, to have the record made, and to have the record kept. Among wonderful things this is perhaps the most wonderful: that any given form of matter should be able to retain a record of events, a record which is made during a state of sensibility for the most part, a greater or less degree of sensibility, which is retained in a state of insensibility, and is finally returned to the sensibility by some curious process of adhesion, and the results of impresses which are found on the material tissue concerned.

And these simple elements of mind are found in animals. No zoölogist who has perception or honesty, nor any farmer or breeder, nor any person who has charge of animals in any way, can deny sensibility to all the lower animals at times. The great stumbling-block in the way of the thinker in all this field is the great evanescence of this sensibility: the great ease with which we dissipate it, the readiness with which we can deprive a fellow-being of his sense, is a stumbling-block in more ways than one. While it is a question of the greatest difficulty, nevertheless, like other departments of nature, doubtless it will ultimately be explained by the researches of physiologists. I only need to call attention to the fact as an important factor in evolution.

Of course, if these structures are suggested, affecting the mechanical apparatus, the question arises, whether they were made ready to hand, whether the animal, as soon as he got it, undertook to use it, and whether he undertook to use the organism under the dire stimuli of necessity, or amended through ages these modifications in his own structure. We are told by some of our friends, that law implies a lawgiver, that evolution implies an evolver: the only question is, Where is the lawgiver? where is the evolver? where are they located? I may say, it is distinctly proven in some directions, that the constant applications of force or motion in the form of strains, in the form of impacts and blows, upon any given part of the animal organism, do not fail to produce results in change of structure. I believe the changes in the ungulates to which I have called your attention are the result of strains and impacts, precisely as I have shown you the manner of the fracture of the vertebral column of the primitive vertebrates of the Permian period. This would require long discussion to render clear: nevertheless, I venture to make the assertion that this series of structures is the result of definite and distinct organic forces, directed to special ends. We have yet to get at the conflicting forces which have produced the results we see. Mechanical evolution will give us a good deal to do for some time to come. Of course, if motion has had an effect in modifying structure, it behooves us to investigate these forces which give origin to motion in animals. First in order come the sensibilities of the animal, which we have traced to simple consciousness; stimuli, upon notice of which he immediately begins to move. The primary stimulus of all kinds of motion is necessarily touch. If a stone falls upon the tail of some animal which has a tail, he immediately gets out of that vicinity. If a jelly-fish with a stinging apparatus runs across an eel which has no scales, the eel promptly removes. External applications of unpleasant bodies will always cause an animal to change his location. Then he is constantly assaulted by the dire enemy of beasts, hunger, an instinct which is evidently universal, to judge from the actions of animals. This seems to have fashioned, in large part, all forms of life, from the least to the greatest, from the most unorganized to the most complex. Each exercised itself for the purpose of filling its stomach with protoplasm. Then come the stimuli, which should be included under the class of touch, changes of temperature. No animals like to be cold or too hot; and when the temperature is disagreeable, the tendency is to go away from that locality. Among primary instincts must be included that of reproduction. After that comes the sensation of resistance, or, carried to a high degree, of anger: when an animal's interests are interfered with, its movements restricted, it prompts to the most energetic displays. So, you see, it is a matter of necessity that mental phenomena lie at the back of evolution, provided always that the connecting link of the argument — that motion has ever affected structure — be true. That is a point which, of course, admits of much discussion. I have placed myself on the affirmative side of that question; and, if I live long enough, I expect to see it absolutely demonstrated.

Of course the development of mind becomes possible under such circumstances. It is not like a man lifting himself up by his boots; which it would be if he had no such thing as memory. But with that memory which accumulates, which formulates first habits, and then structures, especially in the soft, delicate nervous tissue, the development of the mind as well as the machinery of the mind becomes perfectly possible. We develop our intellect through the accumulation of exact facts; through the collation of pure truth, no matter whether it be a humble kind of truth, — as the knowledge of the changes of the seasons, which induces some animals to lay up the winter's store, — whether it be knowledge of the fact that the sting of the bee is very unpleasant, or knowledge of the fact (of which the ox, no doubt, is thoroughly aware) that the teeth of the wolf are not pleasant to come in contact with; or whether it be the complex knowledge of man. When the cerebral matter has become larger and more complex, it receives and retains a much greater number of impressions, and the animal becomes a more highly educated being.

As regards the department of emotions or passions, it is also much stimulated by the environment. Animals which live in a state of constant strife, naturally have their antagonistic passions much developed; while amiable, sympathetic sentiments are better and more largely produced by peace-loving animals. Thus it is that the various departments of the mind have the beautiful results which we now find in the human species.

There are some departments of the mind which some of our friends decline to admit having had such an origin. The moral faculty, for instance, is excepted by many from this series. But the reasons why they object to its production in this way are, to my mind, not valid. The development of the moral faculty, which is essentially the sense of justice, appears to them not to fall within the scope of a theory of descent or of evolution. It consists of two parts. First is the sentiment of benevolence, or of sympathy with mankind, which gives us the desire to treat them as they should be treated. It is not sufficient for justice that it is unmixed mercy, or benevolence, which is sometimes very injurious, and very often misplaced. It requires, in the second place, the criticism of the judgment, of the mature intellect, of the rational faculty, to enable the possessor to dispose of his sentiments in the proper manner. The combination of rational discrimination and true judgment, with benevolence, constitutes the sense of justice, which has been derived, no doubt, as a summary of the development of those two departments of the mind, — the emotions and the intellect.

It is said, that a sense of justice could not be derived from the sense of no justice; that it could not have been derived from the state of things which we find in the animals, because no animal is known to exhibit real justice: and that objection is valid as far as it goes. I suspect that no animal has been observed to show a true sense of justice. That they show sympathy and kindness, there is no question; but when it comes to real justice, they do not display it. But do all men display justice? Do all men *understand* justice? I am very sure not. There are a good many men in civilized communities, and there are many tribes, who do not know what justice is. It does not exist as a part of every mental constitution. I never lived among the Bushmen, and do not know exactly what their mental constitution is; but in a general way the justice of savages is restricted to the very smallest possible circle, — that of their tribe or of their own family. There is a class of people who do not understand justice. I do not refer to people who know what right is, and do not do it; but to the primitive state of moral character, in which, as in children, a sense of justice is unknown. I call attention to the fact, because some of our friends have been very much afraid that the demonstration of the law of evolution, physical and metaphysical, would result in danger to society. I suspect not. The mode in which I understand this question appears to me to be beneficial to society, rather than injurious; and I therefore take the liberty of appending this part of the subject to its more material aspect.

To refer to another topic, and that is to the origin of life, the physical basis of life. The word 'life' is so complex that it is necessary to define it, and so to define it away that really the word 'life' does not retain its usual definition. Many phenomena of life are chemical, physical, mechanical. We have to remove all these from consideration, because they come within the ordinary laws of mechanical forces; but we have a few things left which are of a different character. One is the law of growth, which is displayed in the processes of embryonic succession; secondly, the wonderful phenomena of sensibility. Those two things we have not yet reduced to any identity with the ordinary laws of force. In the phenomena of embryology the phenomena of evolution are repeated, only concentrated in the early stages through which animals have to pass. So whatever explains the general phenomena of evolution explains the phenomena of embryology.

What is the nature of physical sensibility? In this planet, it is found residing only in one form of matter, which has a slightly varied chemical constitution, namely, protoplasm; so-called from a physical standpoint. Now, this world, as you all know, has passed through many changes of temperature. Its early periods, it is probable, were so very hot that protoplasm had a very poor chance. The earth has passed through a great many changes of temperature, many of which would not permit the existence of protoplasm. Again, can we assume for a moment that this little speck in the great universe is the only seat of life? I suppose scarcely any scientific man will venture to do so. If, therefore, life exists in other parts of this great universe, does it necessarily occupy bodies of protoplasm in those different, remote spheres? It would be a great assumption. It is altogether improbable. The certainty is, that in those planets which are in proximity to the sun's heat there could be no protoplasm. Protoplasm in the remote planets would be a hard mineral, and near the sun it would be dissipated into its component gases. So that, if life be found in other parts of this universe, it must reside in some different kind of material. It is extremely probable that the physical conditions that reside in protoplasm might be found in other kinds of matter. It is in its chemical inertness, and in its physical constitution, that its adaptation to life resides; and the physical constitution necessary for the sustentation of life may be well supposed to exist in matter in other parts of the universe. I only say the door is open, and not closed: any one who asserts that life cannot exist in any other material basis than protoplasm is assuming more than the world of science will permit him to assume. And that it is confined to this single planet, and not in the great systems of the universe, — that assumption will not for a moment be allowed. Therefore the subject is one which allows us a free field for future investigation: it is by no means closed in the most important laws which it presents to the rational thinker. I hope, therefore, that, if the evidence in favor of this hypothesis of the creation of living forms be regarded as true, that no one will find in it any ground for any very serious modification of existing ideas on the great questions of right and wrong which have long since been known by men as a result of ordinary experience, and without any scientific demonstration whatsoever.

A classification of the natural sciences.[1]

BY T. STERRY HUNT, LL.D., F.R.S., OF MONTREAL.

To frame a rational classification of the natural sciences, and to define their mutual relations, have often been attempted. The present writer, in an essay read before the National academy of sciences in April, 1881, and since published in the Philosophical magazine, with the title of 'The domain of physiology,' suggested the basis of such a scheme, and now, at the request of some of his readers, ventures, for the first time, to embody in a concise and tabulated form the views then and there enunciated, in the hope that other students may find it not unworthy of their notice.

The study of material nature constitutes what the older scholars correctly and comprehensively termed physics (the words 'physical' and 'natural' being synonymous), and presents itself in a twofold aspect, — first, as descriptive: and, second, as philosophical, — a distinction embodied in the terms 'natural history' and 'natural philosophy,' or, more concisely, in the words 'physiography' and 'physiology.' The latter word has been employed, in this general sense, to designate the philosophical study of nature from the time of Aristotle, and will so be used in the present classification.

The world of nature is divided into the inorganic or mineralogical, and the organic or biological, kingdoms; the division of the latter into vegetable and animal being a subordinate one. The natural history, or physiography, of the inorganic kingdom, takes cognizance of the sensible characters of chemical species, and gives us descriptive and systematic mineralogy, which have hitherto been restricted to native species, but, in their wider sense, include all artificial species as well. The study of native mineral species, their aggregations, and their arrangement as constituents of our planet, is the object of geognosy and physical geography. The physiography of other worlds gives rise to descriptive astronomy.

The natural philosophy of the inorganic kingdom, or mineral physiology, is concerned, in the first place, with what is generally called dynamics or physics; including the phenomena of ordinary motion, sound, temperature, radiant energy, electricity, and magnetism. Dynamics, in the abstract, regards matter in general, without relation to species; chemism generates therefrom mineralogical or so-called chemical species, which, theoretically, may be supposed to be formed from a single elemental substance, or *materia prima*, by the chemical process. Dynamics and chemistry build up our inorganic world, giving rise to geogeny, and, as applied to other worlds, to theoretical astronomy.

Proceeding next to the organic kingdom, its physiographical study leads us first to organography, and then to descriptive and systematic botany and zoölogy, two great subdivisions of natural history. Coming, then, to consider the physiological aspect of organic nature, we find, besides the dynamical and chemical activities manifested in the mineral, other and higher ones which characterize the organic kingdom. On this higher plane of existence, are found portions of matter which have become individualized, exhibit irritability, the power of growth by assimilation, and of reproduction, and which establish relations with the external world by the development of organs, all of which characters are foreign to the mineral kingdom. These new activities are often designated as vital; but since this word is generally made to include at the same time other manifestations which are simply dynamical or chemical, I have elsewhere proposed for the activities characteristic of the organism the term biotics (βιοτικός, pertaining to life). The physiology of matter in the abstract is dynamical, that of mineral species is both dynamical and chemical, while that of organized forms is at once dynamical, chemical, and biotical. All of these, I may remark, I regard as successive manifestations of an energy inherent in matter.

The study of the biotical activities of matter leads to organogeny and morphology, while the relations of organisms to one another and to the inorganic kingdom give us physiological botany and zoölogy. We thus arrive at a comprehensive and simple scheme of the natural sciences, which I have endeavored to set forth in the subjoined table.

[1] Abstract of paper read in general session, Aug. 17, 1883.

Natural Sciences;	Inorganic Nature;	Organic Nature.
Descriptive. General Physiography, or Natural History.	Mineral Physiography. Descriptive and Systematic Mineralogy; Geognosy; Geography; Descriptive Astronomy.	Biophysiography. Organography; Descriptive and Systematic Botany and Zoölogy.
Philosophical. General Physiology, or Natural Philosophy.	Mineral Physiology. *Dynamics* or *Physics*; *Chemistry.* Geogeny; Theoretical Astronomy.	Biophysiology. *Biotics.* Organogeny; Morphology; Physiological Botany and Zoölogy.

PROCEEDINGS OF SECTION A. — MATHEMATICS AND ASTRONOMY.

PAPERS READ BEFORE SECTION A.

[*Continued.*]

Orbit of the great comet of 1882.

BY EDGAR FRISBIE OF WASHINGTON, D.C.

This is a partial record of observations at Washington. Mr. Winlock is preparing a description of all the physical phenomena of the comet which were there observed. The first Washington observation of the comet was at two o'clock on a September afternoon, and a comparison was then made with the position of the sun. Good observations were obtained on the meridian for three days. The calculations from these served to fix the place of the comet with fair approximate accuracy for three months, which was a somewhat remarkable success. Afterward a difficulty occurred in obtaining accurate observations; because there were several different points of light presented in an ill-defined nucleus, and it was uncertain whether the observations always referred to the same luminous point. These observations were made in October and November. The following ephemeris was calculated: —

Sept.	17.2282	ϕ	89° 13′ 42.70″
Ω	346° 1′ 7.91″	log. a	1.9331366
π Ω	69 36 12.79	log. q	7.8904739
i	141 59 52.16	period	793.689

The author compared the foregoing with the observations of other astronomers. The most prominent variation was in respect to the period, which others gave as 659, 997, 852, and 654 years. A contrivance was exhibited, showing the respective positions of the earth and comet, and their directions of motion, by means of pasteboard planes attached at an angle.

The rotation of domes.

BY G. W. HOUGH OF CHICAGO, ILL.

Observatory domes are in general very heavy. As they grow old, owing to the settling of walls and other changes, they are apt to become almost unmanageable. The dome at Chicago is very weighty, every thing about the observatory being built in a very substantial manner. When Dr. Hough first tried to move the dome, he found its two sides working with unequal friction; and this was afterward remedied to some extent, but by no means fully. About two months ago a gas-engine was placed in position to revolve the dome. It was a great satisfaction to see the dome go round continuously, without hitches. The cost of moving the dome by such means is a mere trifle, aside from the first cost of the engine. The use of water-power where that was easily accessible must, however, be preferred in many instances where a sufficient head is supplied by street mains.

Dr. C. A. Young said, in discussing the foregoing, that when he came to Princeton he found a very heavy dome there. One man, using thirty pounds pressure on a two-foot crank, was very tired after giving the dome one turn. A gas-engine has since been put in below, and the power is communicated by a belt. A revolution can be made in four minutes, and the shutter raised in two. In general, the dome is placed and the shutter opened within five minutes. Dr. Young expressed a hope that the Brush storage batteries would furnish electrical illumination and power for the work of observatories, as the electricity might be stored even from a gas-engine operating a dynamo during hours of the day when there was no other use for its power. At present the direct action of a gas-engine on a dynamo, with no intervention between the dynamo and the light, was too irregular to serve the purpose.

Descriptive-geometrical treatment of surfaces of the second degree.

BY J. BURKITT WEBB OF ITHACA, N.Y.

For the purpose of greater conciseness the speaker confined his remarks to the general ellipsoid, remarking that the usual treatment of problems upon this surface — as, for instance, such problems as finding the shade and shadow, or drawing tangent planes — is lacking in generality; the body being taken in such special position, or referred to such special axes, as reduce the general problem to a specially simple one.

The speaker then drew the projections of three conjugate diameters of a general ellipsoid upon the board, stating that this was the best method of defining that body. He then proceeded to find the projections of the enveloping cylinders, and the shadow of the body; which he showed could as easily be done for the general ellipsoid, in a perfectly general position, as for special cases. In fact, it appeared that problems on this body gained nothing in simplicity by special methods and devices which detract from the generality of the treatment.

List of other papers.

The following additional papers were read in this section, some of them by title only: Tidal observations on soundings distant from shore, by *J. M. Batchelder*. Investigation of light variations of Sawyer's variable, by *S. C. Chandler*. Standard time-pointer and a time longitude dial; System of algebraic geometry, by *Samuel Emerson*. The calculus of direction and position, by *E. W. Hyde*. Observations on the transit of Venus made at Columbia college; Description of the new observatory at Columbia college, by *J. K. Rees*. The light variations of T. Monocerotis, by *E. F. Sawyer*. Method of observing eclipses of Jupiter's satellites, by *D. P. Todd*. Conic sections in descriptive geometry, by *J. B. Webb*. Descriptive geometry applied to the general ellipsoid, by *C. M. Woodward*. Some observations on Uranus, by *C. A. Young*.

PROCEEDINGS OF SECTION B.—PHYSICS.

PAPERS READ BEFORE SECTION B.

[*Continued.*]

The tornado at Racine, May 18, 1883.

BY P. R. HOY OF RACINE, WIS.

A CURIOUS mistake preceded the reading of this paper. There was some confusion between the abstracts of this and another paper on a tornado, which were submitted to the sectional committee; and the other paper was entered on the daily programme, but was withdrawn.

Mr. Hoy's paper began by stating that the early part of the day was pleasant, but about 6.45 in the evening two clouds of ominous appearance joined, from opposite quarters of the heavens, and at once the cyclone began. Its general direction was to the north of east. There was no rain at Racine with the storm, but there was noticed a very strong odor of ozone while the cyclone was at its height. At the start it was barely two rods wide, but when it reached Racine it had expanded to twenty rods. Its motion was rotary and oscillatory, and all *débris* was thrown to the centre of the track. When the cyclone crossed the lake it formed huge water-spouts, one central, and seven to eight accessory, whirling about the main trunk.

Prof. H. A. Rowland proceeded to discuss the paper as follows: Most observers of tornadoes just perceive that there is a whirling motion of the air, and it knocks down objects, and that is the principal thing they see. But that is very ordinary observation. Of course, a column of air in such swift rotation will tear houses down, spurt water up, and do every thing of that sort. The particular point which I observed in this paper was the description of the formation of the tornado. The phenomenon which is to be explained is the formation of the tornado, and very few have observed this. This description was very short; merely, that, over in the west or south-west, the clouds formed. Of course, to an observer from the west, one would appear north, and the other south. The point I wish to bring out is, that there was lightning passing between the two clouds. In Mr. Finley's description of six hundred tornadoes, I do not see any similar account. Many observers have seen lightning play around these clouds, but not passing between the two clouds. Mr. Finley applied to me to know whether there was any thing in the electrical theory of a tornado. Of course, any theory of the destruction being caused by electricity, houses being attracted, etc.,—all that is mere nonsense. We know that the attraction of electricity is only a mere fraction of an ounce to the square inch. Before the force becomes sufficient to raise a great weight, a spark passes, and a discharge of electricity takes place. But in this case (these two clouds passing from north to south, and boiling up, having flashes of lightning playing round them), I thought there might be something in the electrical theory, as far as formation was concerned; and I calculated for the signal-service and Mr. Finley what amount of energy there was in two clouds approaching each other in this way. The rotation of the earth will cause them to come together, not in a straight line, but a little aside from each other, forming a spiral motion. The direction of the rotation of the tornado is a necessary consequence of the earth's rotation: so that it might be possible to have these electrified clouds approach each other by mutual attraction, and form a tornado at the point where they meet. I calculated the energy, and found there was sufficient for a rather small tornado in the case I took. I would not be willing to say that is the theory of all tornadoes. I say that it is only possible. There is a great deal more energy in a mass of air heated up to a considerable temperature, and rising, by force of gravitation,—a great many times more. If it were not for the electrical phenomena observed in the case, I should say there was very little probability of the electrical theory. I believe Mr. Finley will direct the signal-service observers to watch the direction of the wind. If it flows in from all directions at the point where the tornado is formed, we should determine it to be due to the rise of hot air at that point. When the ground is very hot and the air very sultry, we have two causes; and it is only by observation that we can find out its true manner. I do not lay very much stress upon the electrical theory. But it is an interesting point, to me, to notice that flashes of lightning have been observed between these two clouds, showing that they were differently electrified, and that there was some plausibility for the theory which I sent to the signal-service.

Prof. F. E. Nipher continued this discussion the next day, as follows: One matter connected with the effects of this tornado contained a point, it seems to me, of sufficient interest to call the attention of observers to the matter, in case any one should have an opportunity to observe the effect of a tornado upon water. Mr. Ferrel, I think, in his description of a tornado, states that we have a rising of the water, forming a sort of cone in the centre of the tornado; the effect being, of course, ascribed to the diminution of pressure which is known to be there. In the cyclone proper, where we have a large area, we have a storm-wave as the principal element in the case, and there is an upheaval of the water in the area of low pressure. In the tornado it seems to me very questionable whether that occurs. I base that upon this observation: A smaller wind-whirl which was observed by myself in northern Missouri, which was rather violent though not destructive, — a column of dust several hundred feet high being raised, — passed out upon a pond of water five or six feet deep, and a depression was formed in the water, extending to the bottom of the pond, — an immense cup. The water was revolving rapidly; and it was thrown into rotation with a centrifugal effect, — the same effect as when a vessel is whirled. It seems to me that this is an element which has not been considered as it should be. If the whirl is small, and you have not only a diminution of pressure in the centre, but of the whole body of the water, the friction producing a rotation of the water, if the result is sufficiently small you might get a depression instead of an elevation. I call attention to this, so that those who may be fortunate enough to see a tornado on the water may not take it for granted that it is all known.

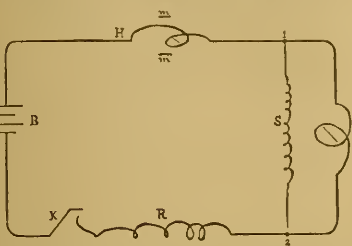
As to the remarks of Professor Rowland in regard to the possible electrical origin of a tornado, I know that he was very careful to say that he did not think any of the destructive effects could be ascribed to the action of electricity. I gathered the idea that he thought a tornado might originate in that way, — that two electrified clouds will attract each other, and come together; and he calculates the energy of the attraction which bodies can have for each other in air. It seems to me that the simple observation that was made by Mr. Hoy, together with another fact which we know, — that when the discharge passes between electrified bodies they are almost wholly discharged, — would show that when that happens the cause for that motion has disappeared. When these two clouds approach, a spark passes, and the whole thing is gone. So long as there is no spark passing, we know very well that the attraction is very much less than the maximum attraction of $\frac{1}{100}$ of an ounce on the square inch. I think, perhaps, that is a matter Professor Rowland did not consider. It does not seem to me at all likely that any such origin can be ascribed to the tornado. When it is developed, you may have a rarefied column which may be very highly rarefied, connecting the earth with the upper regions, which is precisely the reason that the lightning which was observed in the case of the Racine tornado was not accompanied by thunder.

Prof. J. T. Lovewell said it occurred to him, from his observation, that a good deal of care is necessary in order that the observer may know exactly what he sees. It was my fortune, said he, to witness a small whirl at a distance of three or four miles. I saw the funnel-shaped cloud descend toward the earth, and it looked to me as though there were a column of water. Many people who saw it spoke of it as a waterspout. It might have been water, for aught that we could have said from our point of sight. I immediately drove to the spot, and it appeared that not a drop of rain had fallen in that track. The whirl had been sufficient to overturn a few stacks of grain and hay, and a man was thrown about with his team in the road. I think, if it had struck a body of water, I should be slow to believe that it lifted any solid column of water into the air one hundred feet. It would have made a grand scattering of the water, and a great deal of it would have been thrown up into the air. I believe that a good deal of that which is commonly ascribed to columns of water rising up, and pouring down the sides in cataracts, is optical illusion. I should be slow to take the testimony of a person seeing them, unless he had his mind disabused of the common notions about these waterspouts. So far as their electrical origin is concerned, I quite agree with Professor Nipher that it is not by any means proven that electricity has any thing to do with them, except that it is a necessary adjunct, of course, to all such disturbances.

A method for the calibration of a galvanometer.

BY B. F. THOMAS OF COLUMBIA, MO.

A BATTERY of any sort is joined in circuit with a sensitive galvanoscope H, a galvanometer G, and any variable resistance R. When the circuit is closed at K, the current is so adjusted by varying R, as to give the highest desirable deflection of the galvanometer needle. The needle of H will be forced against the stops. By means of magnets m and m, the needle of H is brought back to zero. If these magnets and the galvanoscope be undisturbed, the original current strength will be indicated when the needle stands at zero, whatever changes may have been made in the circuit. If now the shunt S be connected at 1, 2, and the resistance of the shunt is made equal to that of the galvanometer (positively determined), and the needle of H brought back to zero (by increasing R, as insertion of the shunts lowers the total resistance of the circuit, and therefore increases the current strength, deflecting H), a new deflection of the galvanometer needle will be produced, the deflection being that due to a current of one-half the strength of the original current. By giving to S values equal to ∞, 3, 2, 1, ½, ⅓, ¼, etc., times the resistance of G, and bringing the needle of H to zero each time, deflection of G will result, due to currents whose strengths are as 1, ¾, ⅔, ½, ⅓, ¼, ⅕, etc. The curve is then plotted with deflections and current strengths as co-ordinates. Any desired number of points in the



curve may be obtained by giving S the proper values. The calibration may be checked by making a new adjustment for the united current, so that the deflection of G shall be about two-thirds the first deflection, and proceeding as above. Plotting the new values obtained, the curves will coincide if the work is correct. If it be found desirable, the battery may be exchanged for another during the determination.

The utilization of the sun's rays for warming and ventilating apartments.

BY E. S. MORSE OF SALEM, MASS.

MR. MORSE drew attention to this device a year ago, before the National academy of sciences. At that time he was able to offer only crude computations as to the operations of the heater, derived from its use at the museum of Salem, Mass.

The device consists mainly of a slaty surface painted black, standing vertically upon a wall, outside the building, with flues to conduct warmed air to the inside. The slates are inserted in a groove, much as one might place glass in a frame. One made within the last year was three feet wide and eight long. It was placed where it received the sun's rays as directly as practicable. Its service was to warm a room used for a library. During an entire winter the room was thus made comfortable, except on a few of the coldest days. The current of air passing through it, when the sun's rays impinged directly upon it, was raised about 30°; it discharged 3,206 feet of warmed air in an hour. This was in the morning. At 11.45 the air of the apartment was raised 29°, with 3,326 cubic feet of air discharged; at 12.45, 29° and 4,119 feet; at 1.55, 24° and 3,062 feet; at 2.45, 20° and 1,299 feet. The room measured 20×14, and was ten feet high.

The apparatus works to most advantage in a room that is ventilated by an open chimney. But some very good results have been obtained in closed rooms. One was cited, where the air in a public building was raised by such means to nearly 40° above the outside temperature. In general, a difference of 30° to 35° can thus be secured during four or five working hours of the day.

Professor Mendenhall stated that he had seen the working of the apparatus, and it proved very satisfactory. Professor Rogers gave similar testimony.

New form of selenium cell, with some remarkable electrical discoveries made by its use.

BY C. E. FRITTS OF NEW YORK.

PROFESSOR MENDENHALL stated that in the absence of the author he was able to give only a brief summary of the paper. In the ordinary method of making selenium cells, they are constructed of a great many portions put side by side; the resistances are necessarily very high in these cells, and the light is allowed to strike in the direction of a right angle to the direction of the passage of the current. Mr. Fritts seems to have devised a different mode of operating these cells by using a very large surface, and in that way has succeeded in diminishing the resistance very greatly, which is very desirable. He has resistance as low as nine or ten ohms in the dark. The radical point of difference is, that in this case the light is allowed to strike upon the cell in the same direction as the current. He states that he has discovered many remarkable properties by means of his investigations with the instrument. When a cell of this kind breaks down, it can easily be remedied and repaired: in fact, there is no danger or difficulty of their breaking down permanently.

A method of determining the centre of gravity of a mass.

BY B. F. THOMAS OF COLUMBIA, MO.

A BAR, *L L*, is balanced on a knife-edge, *F*, so as to form a very sensitive balance. The body, *B*, of mass, *M*, is placed with a marked point in contact with a fine point, *d*; and another body of mass, *W*, is placed

at *A*, so as to nearly balance *B*. A small body of mass, *p*, is placed at *S*, to complete equilibrium. *B* is then rotated 180° horizontally, bringing its marked spot in contact with a second fixed point, *E*. Equilibrium is restored by placing *p* at *R*. The equations of moments in the two positions are, respectively, —

$$W \times AF + p \times SF = M\,(Fd + dc);$$

(*c* being centre of gravity); and

$$W \times AF + p \times RF = M\,(Fe - dc);\ (ec = dc).$$

Subtracting the first equation from the second, —

$$p \times RS = M\,(de - 2\,cd);$$

$$\therefore cd = \frac{de}{2} - \frac{p \times RS}{2\,M};$$

cd is therefore the distance from the marked spot to a vertical plane containing the centre of gravity. Taking a second marked spot in the plane thus found, the operation is repeated, with the plane horizontal. This gives a second plane through the centre of gravity. A third operation, with the intersection of the two planes in the line *de*, locates the centre of gravity.

The kinetic theory of the specific heat of solids.

BY H. T. EDDY OF CINCINNATI, OHIO.

THIS paper was based upon the well-known views of its author respecting the use to be made of the different degrees of freedom of motion among the atoms of solid bodies, in deducing a theory that will explain their diverse powers of conducting heat, and of transmitting or causing the transmission of radiant energy. The theory is based upon the conception that all bodies are constituted of equal ultimate atoms, whose combination, in different degrees of freedom, in different molecules, gives rise to the characteristic differences of elementary substances. This paper shows that the same hypothesis would cause solids, which are kept in equilibrium by radiation, to be also in thermal equilibrium when brought into contact; the equilibrium depending upon collisions of the molecules.

A kinetic theory of melting and boiling.

BY H. T. EDDY OF CINCINNATI, OHIO.

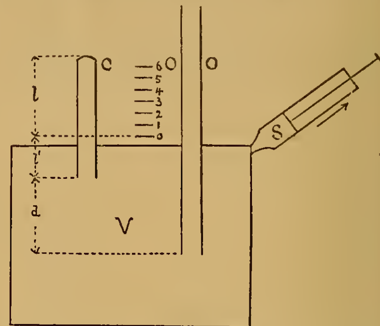
IN a solid in which the molecules are evidently held at nearly fixed mean distances by cohesive and elastic forces, there are two kinds of partially constrained freedom of motion possible for each molecule as a whole: first, a motion of its centre in a small orbit of more or less irregular shape about a mean position; and, second, a more or less irregular pendular motion of oscillation about a mean directional position. Both of these motions can be treated as vibratory motions; and the laws of force under which the motions occur, though somewhat unlike, have a general resemblance.

Two forms of apparatus for Boyle's law.

BY B. F. THOMAS OF COLUMBIA, MO.

THESE pieces are intended to enable one to adjust with accuracy and ease the mass of air to be experimented upon.

V is an iron cistern into which the open or pressure tube O, the closed tube C, and the reversible air-syringe S are screwed air-tight, and the cistern nearly filled with mercury. The syringe being connected for exhausting, and operated, air is withdrawn from C, until the mercury sinks to the bottom of the open tube, when air escapes from it, and rises through the mercury. No more air can be withdrawn from C. The mass of air remaining in C will evidently depend on the difference in depth of immersion of C and O. Let d = this difference, and let it be required to find such a value of d as will permit just enough air to remain in C to fill it from the zero of the scale, when at atmospheric pressure H. Let L = length of C from top to zero, and let l' = the length from zero to the open end of C. If now the mass of air which

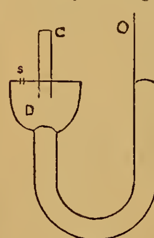


will fill the length l at H be expanded to fill the length l', the pressure H' at the bottom of C by Boyle's law is $H' = \frac{Hl}{l+l'}$.

The pressure at the open end of $O = H$. The difference in pressure at the ends of C and O is that due to a column (d) of mercury. Hence $H' = H - d$. Equating, $H - d = \frac{Hl}{l+l'}$. $\therefore d = \frac{Hl'}{l+l'}$.

On reversing the syringe, and forcing air in, the mercury will be found to rise and stand at zero in both tubes together. The demonstration is continued by forcing in more air.

A second form consists of two glass tubes connected by a strong rubber tube, and mounted on a stand with scales. The closed tube C is sealed into the screw-cover of an iron cistern D. Mercury being poured in, it will expel the air in D, and rise in an open screw-hole S in the cover. The hole being sealed by insertion of the screw, and O lowered, the air in C expands, filling C and D. On raising O, the mercury rises, and cuts off communication between C and D, preventing the return of some of the air. By making D of proper volume, the desired mass of air will remain in C. Let the volume of C above the zero = V. Let the entire volume of $C = V'$, and the volume of D above the open end of $C = V''$. Following the above steps it will be seen that a volume V' at H becomes a volume $V' + V''$ at H'; also that a volume V at H becomes a volume V' at H'. Hence the proportions $V : V' :: V' : V' + V''$, $\therefore V'' = (V' - V)\frac{V'}{V}$. The use of the rubber tube is not new: the method of adjusting the air-mass is be-



lieved to be. This form is convenient because it answers for demonstrating the law at pressures above and below one atmosphere. Of course, for the latter, the air in D must be removed through S as at first.

Natural snow-balls or snow-rollers.

BY SAMUEL HART OF HARTFORD, CONN.

The author carefully described the production and appearance of snow-balls or snow-rollers, the result of natural causes, of which a fine example was presented in Connecticut and southern Massachusetts last February. Snow had fallen, and had been covered with a frozen surface by a light subsequent rain. Upon this surface fresh snow fell, and this under the influence of wind was collected in masses of differing shapes. Some were spherical, from one to nine inches in diameter; most were rollers shaped like muffs, cylindrical, with a conical depression at each end reaching nearly to the middle. The largest observed by the author was 18 inches long, and 12 inches in diameter; but some were reported much larger. The path of formation showed that the roller had started with a small pellet, and, gaining both in length and diameter, had rolled up a long isosceles triangle of snow from its vertex. These paths were observed of a length of 25 to 30 feet, and others were reported as of 60 feet. The paths of the round balls were of nearly the same width throughout. None of these masses could be lifted without breakage. Such rollers were seen over an area of 40 miles in length: the author believed that they must have been millions in number.

Remarks on the tracings of self-registering instruments, and the value of the signal-service indications for Iowa, in June and July, 1883.

BY GUSTAVUS HINRICHS OF IOWA CITY, IO.

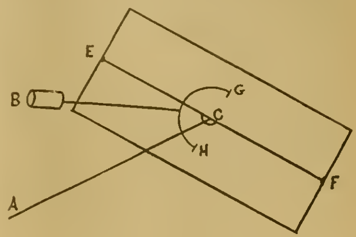
This paper was mainly a severe criticism on the work of the signal-service bureau. The author claimed that the predictions of the weather for Iowa in June had been quite untrustworthy, only 50 per cent proving correct. His views as to the value of this service were vigorously combated in a discussion which followed the reading of his paper.

A new heliostat.

BY B. F. THOMAS OF COLUMBIA, MO.

The instrument is intended to throw the reflected ray horizontally in the meridian.

A polar axis A C, driven by clockwork, is provided with a declination-arm E F, with arc, pivoted at C, and pivoted to the longer axis of the mirror at E and F. A 'horizontal axis' B G H, with the shaft portion B supported (by proper bearings in the standard not represented) in the same vertical plane with the polar axis, is pivoted to the mirror in its shorter axis at G and H, the points E C F G H being always in one plane, and G and H so adjusted that a line through them will pass through C perpendicular to E C F. Moreover, the axis of the shaft portion B, extended, is perpendicular to and bisects G C H at C. In order that the reflected ray be thrown horizontally in the meridian by our mirror, two conditions must be met: viz., 1°. The longer axis of the mirror must make and maintain the proper angle between itself and a line from C to the sun; or, what is



the same thing, the angle A C E must equal latitude plus one-half the sun's altitude at noon. 2°. The shorter axis must move in a vertical plane, perpendicular to the meridian; or, in other words, the prime vertical. These conditions are rigidly met by the above combination.

The static telephone.

BY PROF. A. E. DOLBEAR OF COLLEGE HILL, MASS.

In the static telephone, a ring of hard rubber is used, within which are two parallel metal-plates separated by a body of air (a non-conductor), one plate connected with the line carrying the current. The electrifying of one plate then causes attraction or repulsion of the free plate, and thus a sound in the receiver. This does away with magnetism. This system therefore requires a very large electro-motive power, and uses an induction coil of 2,000 ohms. A ground or return circuit is not present here. The equivalent is the body itself. There is no passage of electricity from plate to plate: the action is purely inductive through space. The insulation is accomplished by the intervening air-space, and by a coating of varnish, — an excellent di-electric. There is a device to discharge the induction plate in connection with this instrument, which keeps it constantly up to its full possibilities. When this instrument is fully charged, and the electrical conditions are perfect, the receiver may be entirely disconnected from the transmitter, and sounds and conversation can still be heard, even across a room.

He also called attention to the fact, that instruments that have been in use work much better than new ones, as each plate acts as a condenser.

In the discussion which followed, Dr. Dolbear was asked if the state of the atmosphere, in any way, affects the operation of the instrument. I have used these instruments, said he, on an actual line between Boston and New York, in a night when it rained over the whole length of the line, and the whole line was as badly insulated as it well could be. I have also used it on the same line under the most favorable conditions for insulation, and could not really perceive much difference. It seemed to be as loud at one time as at another.

Pres. H. A. Rowland. — Of course this is on an entirely different principle from our telephone. What interested me considerably was the fact, that one could hear better when the plates were charged. The explanation theoretically is very simple, and it is the same as that the Thompson electrometer is more sensitive when the jar is charged than when it is not charged; the reason being, that the attraction is proportionate to the square of the difference of the potentials, rather than the simple difference of the potentials. Therefore a small difference in the quantity, when it is large, produces a greater effect than when it is small. So the explanation is exactly the same as that the Thompson electrometer is more sensitive when you have the jar charged than when you do not. So, the higher the charge one would get, the more sensitive the instrument would be. I was especially interested in it, because it was on such an entirely different principle from the Bell instrument. I don't wish to say any thing about patent laws or decisions on this subject, for they have nothing to do with this; but, scientifically, this is an entirely different instrument from the Bell instrument, and I am especially interested on that account.

Prof. T. C. Mendenhall. — I profess not to have quite understood the statement made by Professor Dolbear. I should like to hear your own (the president's) opinion with regard to that charge which remains in spite of the fact that the two poles of the condenser are connected by conductors. I may have misunderstood the statement; but if that is correct, I should like to know whether that can be explained or not.

President Rowland. — Well, I suppose we all know how retentive an electroscope is of a charge. I suppose the idea is very similar in this case. I do not suppose the plates have a difference of potential. If you should leave them for a moment, I should suppose they would soon have a little return charge. If the two plates of the condenser were together, they would have the same potential. I understood it as merely a return charge. I do not know how Professor Dolbear understands it.

Professor Dolbear. — The instrument itself is a most delicate electrometer when tested in this way; and when it is charged and really in good working order, the gentlest tap upon the instrument serves to show that it is in good working order, for one can apply the instrument to his ear and hear himself talk. This is the case, even when the two plates of the condenser are connected with each other through the induction coil; and so, although they may have been there for hours, or even for days, — the difference between an instrument that has not been used and one that has been charged is very appreciable.

President Rowland. — I suppose in that case it would be simply from the charge of the varnished surface?

Professor Dolbear. — Yes: I think they retain their charge for a much longer time if the surface is varnished. I do think there is a difference between the behavior of this and the charged cable. If a cable be charged for half an hour by battery, it will require half an hour to run out again, but it will be at that time quite discharged. But that is not the case with this instrument.

President Rowland. — I should suppose it was the charge in the varnished surface.

Prof. W. A. Anthony. — Professor Dolbear did not say any thing about one advantage that this telephone has over the other, that struck me when I read the descriptions of it earlier, — that, in consequence of using this electricity at such a high potential, the ordinary telegraph-lines or other instruments would have very little effect upon it: therefore the telephone is very free from induction.

Professor Dolbear. — My experience has been in accordance with that theory. Electro-motive force from induction from telegraph-lines is ordinarily tolerably small, although there may be at times considerable strength of current. But, the electro-motive force being so strong in my circuit, it follows that the action of such induced currents is very slight, and does not interfere with work.

Prof. C. A. Young. — I would like to inquire whether you have tried any experiments in putting the end of the wire to the ear to illustrate the sensitiveness of the ear?

Professor Dolbear. — Yes: I have heard simply by putting the end of an insulated wire to my ear, and listening. I consider the instrument as simply the enlarged terminal of a wire, and that you are actually listening at the end of a wire.

Mr. E. Gray. — I have made a good many experiments in another line, which I may state briefly, which may throw some light upon this, and yet I think it is very well understood. You remember, some of you, reading of such experiments made in 1874, relating to the reproducing of music on a plate by simply rapping with the finger or with some animal tissue. Now, I made this experiment, which seems to prove to my mind that the operation is as Professor Dolbear has explained it. I set my revolving disc, which was a simple disc of zinc, revolving at a steady rate, giving it a pressure with the fingers. Then I had fifty cells of battery set up, as much as I could bear, passing through them, and had some one close the circuit with a Morse key. At the same time the key was closed, my finger would be jerked forward in the direction of the rotation of the disc; and it would remain in that forward condition, showing an increase of friction, until the key would be opened, and then it would drop back; showing that from some cause there was an increase of friction, either due to molecular disturbance, or, what is probably the case, to attraction between the finger and the plate. It is necessary, to produce this experiment, that the cuticle be perfectly dry. You must rub it a long time, and have it perfectly polished; and then the cuticle becomes a dielectric, and the body is charged with one kind of electricity, and the wire or the plate with another. Later I got some fairly good results in articulation by using a small diaphragm with all the conditions as nearly right as possible; and, having a current of sufficient electro-motive force, I could actually understand words produced on the end of my finger.

President ROWLAND. — What is the difference between that and Edison's motorphone?

Mr. GRAY. — In Edison's motorphone, when the current was thrown on, there was a decrease of friction; there was chemical action taking place on the surface. In this case there is none, and there is an increase of friction when the current is on: perhaps 'current' is a bad word to use.

President ROWLAND. — The principle is the same.

Mr. GRAY. — One is a chemical action, which causes the friction to be less at the moment of charge. In this case, however, this is purely static contact, and increases the friction in the same manner that the plates are thrown together when they are charged in this telephone. And the motion, of course, or sound, is produced by a letting-go of the finger from the plate, and not by actual vibration, in the same sense that it takes place between the two plates in this receiver of Professor Dolbear.

President ROWLAND. — You attribute it to attraction?

Mr. GRAY. — Yes: my experiments seem to prove that; I presume, because there was adhesion, there was an increase of friction during the time of the charge and the letting-go, when the circuit was open. There was really no circuit except when the charge was taken off.

Sec. F. E. NIPHER. — In regard to the case of which Professor Dolbear spoke, when it might be supposed that electricity does actually pass from the line into the ground, it seems to me that that fact, so far as it did exist, would be prejudicial to the action of the instruments; that what we want to bring about is not a current, but as great a difference of potential as possible, between the plates.

List of other papers.

The following additional paper was read in this section: — An extension of the theorem of the virial to rotary oscillation, by *H. T. Eddy*.

PROCEEDINGS OF SECTION C. — CHEMISTRY.

Report of the committee on indexing the literature of chemical elements.

THE undersigned, a committee appointed at the Montreal meeting of the American association for the advancement of science, "to devise and inaugurate a plan for the proper indexing of the literature of the chemical elements," respectfully submit the following report.

The members have conferred with each other orally and by correspondence. Several plans have been suggested, and their merits discussed. Three methods of collecting material for the indexes may be named: —

1°. Revising the Catalogue of scientific papers published by the Royal Society (8 vols. 4to).

2°. Indexing special journals by different individuals, and collating the matter.

3°. The independent plan, whereby each chemist indexes all the journals available to him with reference to a given element, in which he is presumably especially interested.

Each of these schemes is open to objections, and has its difficulties. The first would necessitate an enormous amount of clerical labor, for which volunteers would scarcely be secured; besides, data previous to 1800 could not be obtained from this catalogue.

The second involves, also, securing a large number of self-sacrificing volunteers; and both plans would require a vast amount of editorial work on the part of this committee.

The third plan seems, to a majority of the committee, the only feasible one at present. On the independent plan, seven indexes have already been compiled. The best arrangement of material has also been considered; and here again a threefold problem occurs: —

1. Chronologically.
2. Alphabetically, by authors.
3. Topically.

The committee do not venture to dictate to independent workers, but recommend the chronological arrangement, with the understanding that a topical index accompany each monograph.

The best channel of publication has also been considered by the committee. All the indexes hitherto published have been printed in the annals of the New-York academy of sciences; and the academy has generously offered, through its officers, to continue its good work. The Smithsonian institution further agrees to distribute, free of expense, all circulars and documents in furtherance of this undertaking; an offer which is of greatest importance, and for which this committee expresses sincere thanks.

Since the appointment of the committee, Mr. Webb's index to the literature of electrolysis has been published in the annals of the New-York academy of sciences; and several chemists have expressed a willingness to co-operate in the proposed undertaking. Prof. R. B. Warder of Cincinnati has promised an index to the literature of the velocity of chemical reactions; and Dr. Henry Leffmann of Philadelphia proposes to index the important element arsenic.

Your committee present to the association this brief report of progress, and respectfully desire to be continued.

H. C. BOLTON, *Chairman;* IRA REMSEN; F. W. CLARKE; A. R. LEEDS; A. A. JULIEN.

PAPERS READ BEFORE SECTION C.

On γ-dichlordibrompropionic and γ-dichlorbromacrylic acids.

BY C. F. MABERY AND H. H. NICHOLSON.

When dry chlorine is passed through β-dibromacrylic acid, the reaction is easily accomplished, and the product may be purified without difficulty by crystallization from carbonic disulphide. This acid is very sparingly soluble in water, more soluble in hot than in cold carbonic disulphide and chloroform. It melts at 100°. Its salts were carefully studied, but the silver salt was found so unstable that it could not be prepared in a state of purity. Since β-dibromacrylic acid has, without doubt, the form

$$\begin{array}{l} CBr_2 \\ \| \\ CH \\ | \\ COOH \end{array}$$

, the chlorine addition product would have the form

$$\begin{array}{l} CBr_2Cl \\ | \\ CHCl \\ | \\ COOH \end{array}$$

. This acid is entirely decomposed when heated with an excess of any alkaline hydrate. If, however, the reaction is allowed to progress in the cold, keeping the hydrate in slight excess, the elements of hydrobromic acid are easily removed, with the formation of the corresponding dichlordibromacrylic acid. In order to distinguish this from two other products which have already been obtained, it will be called the γ-acid. It is prepared by the action of baric hydrate upon γ-dichlordibrompropionic acid, and the reaction proceeds so rapidly that it is difficult to keep the solution alkaline. Upon acidifying the baric hydrate solution with hydrochloric acid, γ-dichlorbromacrylic acid is precipitated partly as a crystalline solid, and is easily purified by crystallization from hot water. It is sparingly soluble in cold, readily in hot water, and in alcohol, ether, carbonic disulphide, and chloroform. It crystallizes in pearly-white scales, which melt at 78° to 80°. For further identification, the acid was analyzed, and its salts submitted to careful study.

The sub-aqueous dissociation of certain salts.

BY JOHN W. LANGLEY AND CHARLES K. McGEE OF ANN ARBOR, MICH.

The question as to whether salts are dissociated into their components when simply dissolved in water has been attacked by different chemists in various ways. The method described in this paper seems to have furnished some remarkable results, which may help in pointing the way to the final answer of this important problem.

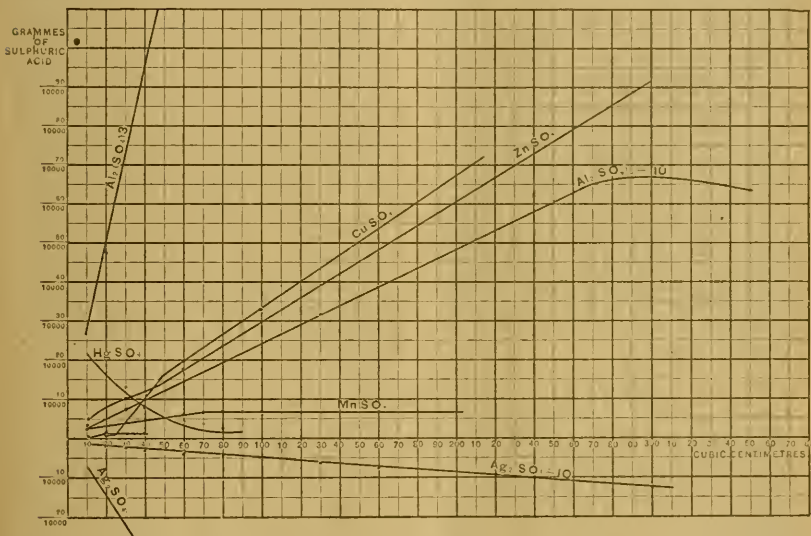
Sainte Claire Deville has called attention to apparent chemical changes which a salt may undergo by the mere fact of solution, and that such changes may increase in extent with the mere addition of water. He concludes that there is no absolute distinction between solution and chemical union; that the difference is rather of degree than of kind. From this point of view, a salt in dissolving has its particles separated much as if it were vaporized by heat, and the heat units necessary to perform this sort of vaporization are taken from surrounding bodies. As the heat absorbed increases with the degree of dilution, it will eventually become sufficient to dissociate into its elements a salt dissolved in a suitably large quantity of a neutral solvent, such as water.

Assuming that salts tend to dissociate by solution, and are decomposed when sufficiently diluted, we should expect them to break into simpler molecules first, and, of course, along the lines of least resistance. We may take three views of the possible condition of a salt dissolved in a small quantity of water — as, for instance, one molecule of sodic sulphate in two molecules of water: 1. That it is attached to the water by a sort of physical adhesion, which may be represented by $[Na_2\ SO_4\ ,\ 2H_2\ O]$. 2. That the water and salt are united in a new group which acts as a compound molecule so long as the amount of the solvent is small; this might be $[2\ (Na\ OH)\ ,\ H_2\ SO_4]$, the comma indicating a molecular as distinguished from an atomic union. 3. That we have in these cases a certain quantity of different kinds of matter held momentarily in equilibrium, but ready to form definite combinations when the external forces change. The last view would be expressed by $[Na_2\ H_2\ SO_6]$, and does not require that Na be combined with H, S, or SO_4.

The heat of combination between $H_2\ SO_4$ and 2Na OH is less than that in the formation of sodium hydrate starting with metallic sodium and water, or of sulphuric acid starting with SO_3 and water. Therefore, in the group $Na_2\ H_2\ SO_6$, the line of least resistance probably passes through where the comma is placed in the arrangement $[2\ (Na\ OH)\ ,\ H_2\ SO_4]$. Then the first stage of dissociation will be the appearance of free sodium hydrate and free sulphuric acid. The change will be partial for finite ratios between quantities of the salt and the water, and should gradually increase with augmented dilution to a point where free acid can be shown quantitatively.

For the present occasion, advantage was taken of the circumstance that in some neutral salts the bases have less power to turn litmus blue than the acids have to turn it red; and also, that in certain other salts the converse is true. Thus the power of the hydrates of zinc, iron, and copper, to turn litmus blue, is quite feeble; while the power of the mineral acids to redden litmus is very great. On the other hand, the hydrates of the alkaline metals are singularly powerful in turning litmus blue. Now, if the power of the base to produce the blue is not the exact quantitative counterpart of the acid to produce red, the difference of color-producing power must increase in proportion as the solution becomes more dilute, if the theory of dissociation is well founded.

The method of experiment may be briefly stated. A series of test tubes was prepared, holding respectively one, two, three, four, etc., portions of sulphuric acid; and each was then diluted with litmus solution to an equal amount. The tubes thus filled presented a series from neutral purple to decided red. This formed a scale of colors for reference. Saturated solutions were prepared of the sulphates of Zn, Cu, Pb, Ag, Ca, Na, Hg, Mn, Al, and Fe, and Zn Cl_2. To each of these solutions, enough litmus solution was added, in a series for each salt, to exactly correspond in amount with the sulphuric-acid tubes. As each tube of a dissolved salt was prepared, and also as it was successively diluted with increasing amounts of litmus, it was compared with the tubes in the color-scale, by looking across the two tubes, until its corresponding tint was found. A complete record of these correspondences was made; and it furnished the means for constructing a diagram, in which the results are plotted in curves.



The following were the chief results: Ca So_4 and Na_2 So_4 each continued to act as a neutral salt, without effect on the litmus throughout the range of dilutions. Ag_2SO_4 was the only salt which changed the solution to a blue. The results with Fe_2 $(SO_4)_3$ and Fe SO_4 were unsatisfactory because of a dirty precipitate, but both made the litmus red. Zn Cl_2 presented a similar difficulty. There is a doubt about the result with Hg SO_4, and some obscurity about the greatly diluted solutions of Al_2 $(SO_4)_3$ and Cu So_4.

On account of instability of color, probably caused by oxidation, a fresh color-scale had to be prepared every day, and the mixtures were made under a film of paraffine.

These experiments seem to indicate that: 1°. Sulphates of the alkali metals, except silver, are strictly neutral under all degrees of dilution. 2°. Sulphates of the R. SO_4 type, where R is a dyad metal, show an amount of dissociation proportioned to the degree of dilution. 3°. Aluminic sulphate, and other double triads, are not neutral when concentrated. When diluted they soon become strongly acid. When the dilution exceeds a certain limit, they lose acid at a decreasing rate.

Suggestions for computing the speed of chemical reactions.

BY R. B. WARDER OF CINCINNATI, O.

THIS paper urges a thorough discussion of data upon the subject indicated in its title, for the following reasons: 1°. To discover and investigate the causes of certain discrepancies between published observations and current theories. 2°. To obtain more definite information as to the nature of certain reactions and the conditions determining their speed. 3°. To afford numerical data for a fuller study of relations between the speed of reactions and other physical constants. 4°. To suggest fruitful lines for further research in chemical dynamics.

As instances of the need of such discussion, the determinations by Professor Menschutkin, of the speed and limits of the etherification of the several alcohols and acids, give numbers for the initial speed of reaction in one hour which are not proportional to speeds during the first minute. Prof. L. Meyer in his *Dynamik der atomen* passes very lightly over both the theory and the observations of speed during a reaction.

The prevalent theory of the action of mass is expressed, $\frac{du}{dt} = kuv$ . . . in which the differential expresses the rate of change in any substance, u and v represent the masses taking part in the change, and k is a constant. Some observations by Ostwald and others indicate that some modifications of this theory are needed. Determinations of the speed of reaction require special care, both to measure time in relation to mass, and to control temperature and other conditions. The chemical section of the Ohio mechanics' institute has recently undertaken some work of the sort, and invites co-operation.

The following provisional system is suggested: for volume, one cc.; for mass, the chemical equivalent expressed in mg.; and for time, one hour. The unit of speed would be the transformation of unit of each active body per unit of volume and time. Possibly the comparison of the constants of speed or of chemical affinity with those of heat, electricity, etc., could be better made from the unit of one second or 1,000 seconds. At least two observations of time and two of mass are required, and preferably several, to determine the limits of error. Determinations which do not accord with the hypothesis that diminished speed and diminished product vary in the same ratio, need special investigation. In reciprocal reactions, some of the ratios may be combined with constants of speed already determined. By bringing all the facts into systematic order, these data can be made of use for comparison in other physical-science fields. The paper concludes with an extended bibliography of the subject, which will be very serviceable to workers in this branch of research.

Twelve months of lysimeter record at the New-York agricultural experiment station.

BY E. L. STURTEVANT OF GENEVA, N.Y.

THE lysimeters were described. They are boxes of peculiar construction, containing selected samples of soils in layers. The relative percolation of rainfall through these different soils, and the evaporation, are determined by observations of the instrument. The results are summarized as follows: Sod land allowed 11.68 of the rainfall to percolate; soil of which the surface was simply bared allowed 25.88 per cent percolation; the cultivated soil passed 37.93 per cent. The evaporation from the first of these was, of course, 88.32 per cent; from the second, 74.12; from the third, 62.07; the sum of percolation and evaporation being held to account for the entire rain-fall.

The composition of American wheat and corn.

BY CLIFFORD RICHARDSON OF WASHINGTON, D.C.

THIS paper gave an account of results obtained by the author in his work as first assistant chemist of the U. S. department of agriculture. More than 200 analyses of wheat, and 100 of corn, have been made during the last ten years under his supervision. It appears that while our wheats are of somewhat lighter weight, they contain less water, about the same ash, more oil, less fibre, and less albumen, than the foreign wheats. Among our wheats, only those from Colorado, Dakota, and Minnesota equal the European in albuminoids and in size of grain. The wheats of the Atlantic states are poor in nitrogen. Corn, compared with wheat, contains twice as much oil, less starch, more water and fibre, and less of albuminoids. The following table gives a condensed statement of the wheat analyses: —

Average percentage of nitrogen, albumen, etc., in wheats of the world.

COUNTRIES.	No. of analyses.	Per cent of nitrogen.	Per cent of albumen.	Highest albumen.	Lowest albumen.	Weight of 100 kernels.	Highest weight.	Lowest weight.	Authority.
Russia	24	3.12	19.48	24.56	10.68	–	–	–	Laskowsky.
Russia	5	2.34	14.63	16.56	14.24	3.610	5.350	2.000	Von Bibra.
North Germany	25	2.24	14.00	18.26	9.80	4.498	5.400	4.000	" "
South Germany	13	2.17	13.56	17.76	10.21	4.485	7.000	2.875	" "
Germany	–	2.11	13.19	–	–	–	–	–	Kühn.
Germany	–	2.08	13.09	–	–	–	–	–	Wolff.
Spain	8	2.10	13.13	15.29	11.26	4.270	5.125	3.275	Von Bibra.
France	–	2.08	13.00	–	–	–	–	–	Reiset.
Scotland	14	2.01	12.56	–	–	4.680	5.200	4.250	Von Bibra.
Australia	2	1.60	10.00	–	–	–	–	–	" "
Egypt	5	1.47	9.19	9.92	8.75	5.540	–	–	" "
All but Russia	176	2.29	13.65	19.10	5.33	–	–	–	Koenig.
America	254	1.92	12.00	17.15	8.05	–	5 924	1.830	Various.
America, except Colorado . .	163	1.86	11.62	16.63	8.05	3.532	5.079	1.830	"
Colorado, 1881	33	2.14	13.40	15.94	11.19	4.833	5.924	3.851	Richardson.
Colorado, 1882	12	2.09	13.06	14.88	11.55	4.299	4.670	3.976	"
Minnesota	12	2.05	12.79	17.15	10.85	3.354	3.699	3 116	"
Michigan	38	1.92	12.00	14.47	9.13	4.116	–	–	Kedzie.
Missouri	10	1.83	11.44	12.44	10.50	3.502	3.867	3.098	Richardson.
Oregon	7	1.46	9.17	10.63	8.05	4.800	–	–	"
Atlantic States	56	1.79	11.18	14.00	8 93	3.057	4.628	1.830	"
Pennsylvania	23	1.80	11.25	12.78	9.45	3.211	4.063	2.526	"
North Carolina	21	1.67	10.46	12.43	8.93	3.782	4 628	2.780	"
Alabama	17	1.82	11.32	13.65	9.80	3.137	4.647	2.011	"

The sotol, a Mexican forage plant.

BY CLIFFORD RICHARDSON OF WASHINGTON, D.C.

This plant, Dasylinion texanum, grows wild and extensively on the borders of the Rio Grande and elsewhere in Texas, and in Mexico, on a rocky and gravelly soil. The plains covered with it look like a vast cabbage-field. Sheep feeding on it go without water for many weeks. Only the bulb is eaten. It is split open by the shepherd, who carries a knife for the purpose. Mexicans eat the bulb after roasting or baking it in pits. Also a liquor is obtained from it, by fermenting and distilling after roasting, called 'sotol mescal,' and possessed of highly intoxicating powers.

The plant is described in Watson's Revision of the North-American Liliaceae. About 18 per cent of sugar can be obtained from the outer husks; in the interior, more than 10.5 per cent exists: and in the whole head of the plant there is probably more than 15.5 per cent of sugars. No starch seems to be present.

A proximate analysis of the soft interior of the head gave 17 per cent sugars: 65 per cent of this soft substance in the head, when fresh, is water.

As a food-plant in dry districts, the sotol is of great value; as a fibre-producing plant, it will not be of any importance, owing to the shortness of the cells.

American butters and their adulterations.

BY H. W. WILEY OF WASHINGTON, D.C.

A series of elaborate experiments and analyses of various samples of butter, oleomargarine, tallow, and lard, have been made by Professor Wiley, chemist of the U.S. department of agriculture. The paper contained a description of Professor Wiley's method. He takes a weighed quantity of the butter, puts it in a sand-bath, and dries for two hours at 100°. The curd or caseine is determined by ignition: five grains are used for the purpose. Dry combustion in a tube is difficult and unsatisfactory: he therefore uses the moist-combustion method, with permanganate and nesslerizing. The amount of salt he considers important. It is usually determined by ignition, and weighing the residue; but he found that so much chlorine was thereby lost, that the result was not trustworthy. He washes the butter by shaking it in a separating funnel with hot water, and then determines the chlorine with standard silver nitrate and potassium bichromate as an indicator.

Professor Wiley has devised several novelties for these analyses. One of the neatest is for ascertaining the melting-point. The butter is packed in a U-shaped tube, of which one leg is longer than the other. The tube is placed upright in a vessel containing sufficient mercury to overflow the top of the tube. This vessel is placed in another containing water, and heat is applied beneath. The water, heated, in turn heats the mercury surrounding the tube, until the contents of the tube are melted. As soon as the melting takes place, the melted material leaves the tube, and floats on the surface of the mercury. Another method consisted in laying platinum wires upon the sample of butter, etc., heating the wires, and noting the heat required to cause them to disappear by sinking into the sample. These methods determined not only the melting-point of samples of butter, oleomargarine, tallow, and lard, but also of the fatty acids. But the variations in the melting-point of genuine butter are so wide, that no certain conclusion can be arrived at by comparison with melting-point of oleomargarine, etc., to test the question of genuineness. Thus it was found that first-rate butter from an Alderney cow at one time, owing to special feeding, had a higher melting-point than oleomargarine; while a few weeks later, with different food, the same cow supplied milk from which was made butter with a lower melting-point than oleomargarine.

In regard to other tests, concerning which full details were given in the paper, it may be briefly stated, that, as a general rule, the amount of caseine present in pure butter is much greater than in oleomargarine. The specific gravity of genuine butter is lower. The saturation co-efficient for the insoluble acids in the genuine butter is low, in the imitations it is high. Professor Wiley seems to place more reliance on tests for saturation co-efficient than on other methods. The soluble fatty acids in pure butter range from three to five per cent; while in oleomargarine, tallow, etc., they are either absent, or show a mere trace. The author also called attention to polarization tests. The genuine butter gives a uniform field in polarized light: oleomargarine gives a field with mottled and crystalline structure. He had made no analysis of butter known or suspected to be adulterated by mixture. He considered it unwise to decide the question of genuineness from any one of the constituents or conditions of a sample; believing that all the different tests should be brought to bear. He presented elaborate tables of analyses of different kinds of butter, etc; specifying for each the place of purchase, name sold by, price, color, percentage of water, of caseine, of salt, specific gravity at 40°, melting and solidifying points, percentage of soluble and of insoluble acids, and the melting and solidifying points and the saturation equivalent of the insoluble acids.

The discussion respecting the analysis of butter which was brought about by this paper revolved around the question of the value of the data presented for the practical work of the determination of actual proportion of adulteration. Mr. Noyes held that the variations in pure butters in specific gravity, in melting-point, in saturation co-efficient, and in caseine, as determined by Professor Wiley, would be of little value except in cases where the adulteration was very great. Mr. Springer held that the principal constituent to be taken into account in the determination of adulteration was the amount of caseine, and that although there were some difficulties in the way of its accurate determination, they might be removed, and he should then have more faith in this than in the comparison of other data. He suggested that the accurate determination of caseine might be effected by some rapid-fermentation process by which caseine could be broken up into other organic products that could be separated by albumen. He held to this point as to caseine, because it cannot conveniently be added in the manufacture of oleomargarine; while the acids upon which the saturation co-efficient depends could readily be added as sodium compounds.

On account of the difficulty of getting accurate results in determining nitrogen, it was thought best to use the wet-combustion method with permanganate, because a small quantity of material might be used, and there would be fewer chances for loss that otherwise occurs in nitrogen determinations that are effected by the combustion of butters.

Dr. Wheeler called the attention of the section to the use of what is known as 'cotton-seed-oil stock,' in the manufacture of oleomargarine. This, doubtless, contains considerable nitrogen, and, of course, would reduce the value of the caseine-test for adulteration. A sample was shown, supposed to contain cotton-seed-oil.

The sense of the discussion was, that it was very desirable that Professor Wiley should continue his experiments, as they are of great value; but there is yet a great deal of work to be done in the investigation.

List of other papers.

The following additional papers were read in this section:— The formation and constitution of chlordibromacrylic acid, by *C. F. Mabery* and *Rachel Lloyd*. Orthiodtoluolsulfonic acid, by *C. F. Mabery* and *G. M. Palmer*. Estimation of carbon and nitrogen in organic compounds, by *C. Leo Mees*. New forms of burettes, by *W. H. Seaman*.

PROCEEDINGS OF SECTION D.—MECHANICAL SCIENCE.

PAPERS READ BEFORE SECTION D.

A comparison of terra-cotta lumber with other materials.

BY T. R. BAKER OF MILLERSVILLE, PENN.

The material called 'terra-cotta lumber' is made out of clay and sawdust. The investigation which formed the subject of this paper was to ascertain certain qualities of this artificial product. The paper also described the apparatus used for the tests. The results indicated that the material was 875 times as permeable to air as pine, and 135 times as brick. Air was forced by pressure of a column of water. Other tests showed that the material was four times as hard as pine, but not so hard as brick. Its grip on nails driven into it was about half that of pine. The author was careful to disclaim any intention of advertising the merits of the material, but he evidently regarded it as serviceable for the purposes for which it is intended. Specimens were exhibited.

Improvements in shaping-machines.

BY J. BURKITT WEBB OF ITHACA, N.Y.

In the ordinary shaping-machine there are two defects, one of which is found also in the planer. The ram of a shaping-machine is a bar sliding in bearings, and carrying at one end the cutting-tool. If we represent by a the variable horizontal distance from the tool to the first bearing (or nearest end of the long bearing), and by b the variable horizontal distance from the tool to the second or farthest bearing (back end of long bearing), and by c the length of stroke, we shall have,—

Maximum value of a = (minimum value of a) + c.
Maximum value of b = (minimum value of b) + c.

In other words, the length of the ram is variable, and the spring of the ram from the work is variable, the tool springing away from its work more at the end of its stroke. This springing takes place mostly in the joint between the ram and its bearings, and cannot be wholly avoided without a change of construction. To remedy the defect, the author proposes a reversed construction of the sliding parts; the two bearings (preferable to a long bearing) to be formed on the ram, so as to make the distances a and b constant, and the long slide being part of the bed of the machine.

The second defect, which is also common to the planer, is in having a 'drop-block' which fits but indifferently between the jaws and against the bottom of its seat. From the necessity of the usual construction, the tool attached to this block will have more or less spring. The remedy is to dispense with the drop-block, and introduce an automatic motion to lift the tool on the return stroke, as has been done, the author has understood, on some large machines.

Regularity of flow in double-cylinder rotary pumps.

BY J. BURKITT WEBB OF ITHACA, N.Y.

The speaker introduced his subject by exhibiting a number of models of these pumps from the cabinets of Cornell university, which has recently purchased copies (243 in number) of the celebrated models of the Reuleaux collection in Berlin. Class I. of this collection is devoted to these pumps. The speaker then produced and demonstrated a formula for the flow of these pumps, and showed that the regularity of flow depended upon other principles opposite to those which have been given for determining this point. The formula given for the flow was:—

$\pi[R'^2 + R''^2 - (r'^2 + r''^2)]$ = Flow for one revolution, when R' and R'' (generally equal to each other) are the extreme radii of the two revolving wheels; and r' and r'' are the radii (often, perhaps generally, variable) from the point of contact between the wheels to their centres. It was shown that the regularity of flow depends upon $r'^2 + r''^2$ = constant. R' and R'' may be called the 'piston radii,' and r' and r'' the 'valve radii.' These pumps are called by Reuleaux 'Kapsel räderwerke,' or 'chamber-crank trains,' according to Kennedy.

List of other papers.

The following additional papers were read in this section, some of them by title only: — A method of testing long plane surfaces, applicable to the alignment of planer-beds, lathe-beds, heavy shafting, etc., by *W. A. Rogers*. The commercial and dynamic efficiencies of the steam-engine; Centrifugal action in turbines, by *R. H. Thurston*. Velocity of the piston of a crank engine, by *C. M. Woodward*.

PROCEEDINGS OF SECTION E. — GEOLOGY AND GEOGRAPHY.

ADDRESS OF C. H. HITCHCOCK OF HANOVER, N.H., VICE-PRESIDENT OF SECTION E, AUG. 15, 1883

THE EARLY HISTORY OF THE NORTH-AMERICAN CONTINENT.

There is a special appropriateness in the association of geography with geology, as indicated in the assignment of sciences to section E; for the latter gives us an account of the origin of every topographical feature of the earth's surface, whether island, continent, mountain, plateau, valley, or oceanic depression. If we would properly understand the significance of the earth's contours, we must unravel the mysteries of geology: so a knowledge of topography is essential to the complete comprehension of the geological features of any country. If a geologist were taken by a balloon to an unexplored part of the earth, he would instantly recognize, from their topographical outlines, volcanic and granitic cones, limestone hills, elevated plateaus of basalt or horizontal sandstones, and special types of orographic structure. Hence the modern geologist first draws the contours of his district before applying the colors of geological age. The existing relief features of the earth have been produced one by one in successive periods; and it is the task of the geologist to discover what were the characteristic physical developments of the several ages. He can delineate a connected historical sketch of the beginning, growth, and completion of a continent. Such histories are rare, because attention has but recently been turned into this direction. One of the first American geologists to frame such an outline is Prof. J. D. Dana, to whom we owe the enunciation of this fundamental truth, — that the first formed land has always remained above water, and has been a nucleus about which zones of sediment have accumulated. We can now recognize this primitive continent, with all its successive stages of growth, upon every geological map.

Time would fail us to present the entire physical history of our continent; and we will therefore confine our attention chiefly to its earlier chapters, noting those points which are under discussion. As we are endeavoring to *advance* science, we must touch upon debatable topics, and hope by friendly discussions to become wiser.

We must assume the correctness of the commonly received opinions concerning the earliest history of our planet, — that it passed through the condition of a nebula, and then of a burning sun, the period of igneous fluidity. By subsequent refrigeration it has become either partially or wholly solid. Not until a crust had formed, and the earth had cooled enough to allow water to remain permanently, was it possible to talk of dry land and ocean. With these premises allowed, it seems to us evident that the material of the earth must be disposed in concentric zones, arranged according to density, the heaviest being at the centre. If the various elements were free to move, as is the case in all natural or artificial igneous fluids, we must expect to find the heavier metals situated beneath the others; and, following the analogy of extra-terrestrial bodies, the central nucleus may be principally iron, like the heavier meteors. Zones corresponding to stony meteors, lavas, the trap family, and granites would naturally succeed in order, the last named being at the surface. This outer zone is also characterized by the presence of much silica and oxygen. The primeval ocean came from the vapors surrounding the igneous sphere, condensed to liquidity as soon as water could remain upon the solid crust without immediate vaporization.

This original crust may have been essentially a plain, and consequently entirely covered by water; for if the land were now levelled off, the ocean would submerge every acre of the continents. As refrigeration progressed, ridges and valleys would form in accordance with that fundamental principle that the outer envelope must conform to the shrunken nucleus; and this contraction gives rise to that tangential force or lateral pressure which has acted through all time. Whether these earliest ridges rose above the ocean would depend upon the amount of elevation. Some authors argue that these ridges follow the course of great circles. If there are causes adequate to produce such results, — or any other world-wide arrangement, — they must have commenced to operate at the very beginning of contraction. Most authors maintain that the very thick strata of the older rocks have been formed just like modern sediments, having been broken off the ledges, and transported into oceanic basins in horizontal attitude. If so, there must have been great mountainous elevations, deep oceanic depressions, and extensive aqueous action; since the thickness of the crystalline schists is greater than that of the strata in the fossiliferous ages. The amount of distortion, crumpling, and faulting of the crystalline rocks is also greater. These same authors hold that the original strata were in all respects like modern sands, gravels, and clays, and that their present crystalline structure is due to metamorphism. No one has yet discovered any uncrystalline pre-Cambrian beds; nor have the original foundation rocks been pointed out, since the oldest known layers are stratified, and cannot therefore have constituted part of the original unstratified crust.

Professor Dana thinks the primitive land originated because of a difference in the rate of conduction of heat during the process of refrigeration. Cooling would be fastest where the heat was conducted most rapidly. The first areas to cool would be the first to solidify. The first solidified crust was heavier than the adjacent liquid: so it sank until it found a fluid as dense as itself. Then the liquid above this crust would in turn become solid, and sink; and this process is supposed to have continued until a permanent shell had become fixed in the earth's circumference, which constantly increased in breadth and thickness, becoming continents. Meanwhile the other portions remained liquid; and their surfaces must have stood at the same level with the first-formed crust till that congealed, and became depressed because of the diminution of volume in solidification. These depressions became the ocean's beds. From this beginning down to the present time the processes of growth have consisted in the thickening of the continents and the settling-down of the oceanic depressions, while the chief force employed has been the lateral pressure derived from contraction. LeConte and Pratt express the process thus far described by the term 'unequal radial contraction.' The total gravity of the particles of matter along each radius is supposed to be the same; and hence, if the heat is conducted most rapidly over the shorter radii composed of denser minerals, the ocean-basins would cool first. These two views thus demand a different arrangement of the lighter and denser materials; the one necessitating that the continents, and the other the depressions, were first to congeal. Both, however, make the gratuitous and unproved assumption, that the surface was not uniform in composition; the differences being probably like that between granite and trap. The principle stated above — that, where all the particles are free to move in a liquid, the lighter elements must rise to the surface, and the heavier minerals sink down in proportion to their specific gravity — is at variance with this assumption. Fortunately it is not essential to a right theory of continental growth. There is no reason, therefore, to doubt that the original crust had essentially a uniform thickness over the whole earth. Contraction would originate ridges and valleys in the normal way, most likely of similar dimensions. There must soon burst forth ejections of igneous matter, owing to tidal attraction; and these would show themselves along the weakest lines. At the outset it is difficult to assign reasons why either the elevations or depressions would be the weaker; and hence we should look for a multitude of locations of igneous overflow, both over the future continents and oceans. There may be no better reason for the eventual enlargement of certain of these volcanoes than that circumstances only very slightly favored them; but, this favor being continued, they would exist and enlarge at the expense of the others, affording us another illustration of the 'survival of the fittest.'

It seems to us there is now afforded an opportunity for reviving in a modified form the view of Poulett Scrope in regard to the origination of the earlier crystalline deposits. Suppose we say, that, besides the original unstratified igneous granitic material, the oldest stratified crystalline rocks are derived from volcanic ejections; being the continued enlargement in size, and reduction in number, of the early indeterminate vents. The several ejections would increase in size till they became islands, either gneissic or granitic; and, if an archipelago is allowed us, we can easily show how continents would accumulate, using only the universally acting forces of lateral pressure and sedimentary accumulation.

Of other theories relating to the origin of the earlier crystalline beds I may mention two. The first is that advocated by Lyell, who termed these rocks *hypogene*. After the solid granitic crust had been formed by refrigeration, "the hot waters of the ocean held in solution the ingredients of gneiss, mica-schist, hornblende-schist, clay slate, and marble, — rocks which were precipitated one after the other in a crystalline form" (Lyell's Principles of geology, 10th ed., i. 142). In such a menstruum, life could not have existed. A very similiar view was advocated by Dr. T. Sterry Hunt in his presidential address before this association in 1871.

The second is the view more commonly entertained, — that, after the solidification of the crust, sedimentation accumulated stratified systems from the granitic foundations, as ordinary sand, gravel, and clay, which were subsequently acted upon by thermal and aqueous influences termed *metamorphic*, and thus converted into crystalline schists. The wide-spread and powerful action of metamorphism is conceded; but it is a more appropriate adjunct to volcanic than sedimentary accumulation.

A few of the considerations favoring our theory will now be presented.

1. Considering the igneous origin of the earth, volcanic energies would naturally continue their action as soon as there was a crust to be broken through, and immense piles of melted rock would ooze from the numerous fissures. Up to Laurentian times all admit the universality of igneous outflow, while but few have ventured to speak of any thing like volcanic action, except as it has been manifested in the formation of dikes in these early periods. There has been a tendency to class the ancient granites and porphyries with rocks of sedimentary origin, and consequently to restrict the action of igneous agencies to phenomena of slight importance. Several English writers, and, in our country, Dr. Selwyn of Canada, have been calling our attention to the existence of a volcanic group in later Huronian or early Cambrian times. These are the rocks so largely developed about Lake Superior, New England, and the Province of Quebec, consisting of stratified schists, diorites, diabases, amygdaloids, and felsites, identical in composition with true eruptive masses of the same name. Investigation shows that

oftentimes these schists are disposed like the lavas ejected from one series of volcanic vents. Suppose, for example, that Etna or Vesuvius should become extinct. In the course of ages the rains would obliterate the craters, and reduce the lavas to a rounded dome of greater or less regularity. We should recognize the volcanic origin of the mountain in the absence of craters from the lithological similarity of the rocks to those known to have been melted and ejected from vents, while the disposal of the material in a conical attitude shows us that it might once have been covered by craters. So we find in our eastern country many domes of diabasic or protogenic schists, whose volcanic origin may be predicated, both from their lithological character and physical aspect.

Now, this volcanic group of Huronian times indicates the existence of a greater degree of igneous activity than has been described for the paleozoic ages, even those of Great Britain ; and consequently this is an indication pointing significantly towards the predominance of thermal influences in the still earlier periods. In the Laurentian age the fires should have been yet more vigorous, because the time of universal igneous fluidity was less remote.

2. A careful study of the crystalline rocks of the Atlantic slope indicates the presence of scattered ovoidal areas of Laurentian gneisses. Those best known have been described in the Geology of New Hampshire. Instead of a few large synclinal troughs filled to great depths with sediments, the oldest group is disposed in no less than twenty-two areas of small size, scattered like the islands in an archipelago. In a chapter upon the physical history of the state, I have proposed the theory that the earliest land within its limits consisted of this series of islands, not packed as closely together as now, in an area of perhaps three thousand five hundred square miles, but as much more widely separated as would be determined by smoothing out the various anticlinals and synclinals that were formed later. By reference to our maps in Maine, Massachusetts, New Jersey, Pennsylvania, Virginia, North Carolina, and Georgia, many similar ovoidal Laurentian areas may be specified, usually larger than those of New Hampshire. This may be due partly to a less thorough knowledge of the exact areas occupied by this older gneiss, and partly to the existence of a greater number of volcanic vents, giving rise to a more widely spread and thicker mass of ejected material. Over the Atlantic slope and Canadian highlands these primeval islands have, in later periods, been cemented together by a subsequent deposition of material; but in Missouri, Arkansas, and Texas, we recognize, even now, these early islands.

3. The lithology of the Laurentian and other crystalline rocks is very like that of igneous ejections. It is proper at this point to recall the proper restriction of the term Laurentian. As originally defined by Logan, it included every formation that antedated the Huronian. In the Report upon the geology of Canada for 1877–78, Selwyn proposes to restrict the Laurentian outcrops to "all those clearly lower, unconformable, granitoid, or syenitic gneisses in which we never find interstratified bands of calcareous, argillaceous, arenaceous, and conglomeratic rocks." The Hastings and Grenville series, and all the schists containing the eozoon, are excluded from the Laurentian by this definition, as well as the Bethlehem, Lake Winnipiseogee, and Montalban groups of the Atlantic slope. The Laurentian is azoic, the other groups eozoic; and, unless newer distinctions are to be made hereafter, it looks as if we might claim these various azoic Laurentian islands as the first-formed dry land, as they certainly are the nuclei of the existing continents.

There are no minerals in these Laurentian islands that do not occur in eruptive granite; and the schistose structure is often so faint that the field geologist need not be blamed if he acknowledges his inability to detect it. Likewise we discover the same fluidal inclusions and the vacuoles that pertain to granite. If we follow Sorby and Clifton Ward in saying that granite has been formed beneath a pressure equivalent to a weight of forty thousand feet of strata, the same must be said of the early gneisses. With this general assertion of the identity of gneiss and eruptive granite, we must be satisfied at present, without entering into detail.

4. The analogy of the origin of oceanic islands at the present day suggests the igneous derivation of the Laurentian areas. Most of the high islands of the Pacific are composed of lava, with the volcanoes frequently in action. Hawaii, of the Hawaiian group, may illustrate their position and shape. Its area above the water-line is 4,210 □ miles, and its cubical contents above the sea-level are about the same with those of New Hampshire. It rises from a plateau over 16,000 feet deep, thus forming a cone 30,000 feet high, whose cubical contents must be twenty times greater than the portion making dry land. The length of the entire series of islands, all of similar character, is 350 miles, and the area of the base of the lava must be about 100,000 □ miles. These cones have been built up by the accumulation of lava ejected from the interior of the earth, and they are entirely isolated, the nearest land being 1,000 miles distant. The ground-plan of this volcanic mass is that of two elliptical areas, either of which is like some of our Laurentian islands, and is certainly as large as any of these ancient lands south of the St. Lawrence. The land area of the Hawaiian Islands is less than that of Massachusetts, but their base must be equal to the whole of New England and New York combined. Surely it cannot be avowed that volcanic areas are too small to be compared with the space occupied by our oldest formation.

The so-called lowlands are likewise of volcanic origin; since coral polyps have built up reefs upon the igneous area after the disappearance of the fire, and the Hawaiian areas are encircled by reefs. After the volcanoes have become cold, loose material would be worked in between them, coral reefs would grow, and, in various ways, the land area would be enlarged, and finally an archipelago may become a large island. It needs only time and a repetition of these constructive agencies to make a continent out of a series of archipelagos.

There are two points requiring explanation in this connection, — first, the supposed deeply seated localities where granite is produced; and, second, the origin of foliation in the schists.

We should naturally expect that the earlier igneous rocks would have been derived from reservoirs quite near the surface, because of the thinness of the crust. With this notion agrees the presence of cavities containing liquid, and of hydrated minerals, which are more common in the older eruptive rocks, and have led to the aqueo-igneous theories of the origin of granite. Water would be scarce at great depths, and hence these rocks ought to originate near the surface where moisture was abundant. It seems to us that this consideration should more than balance the arguments usually cited in favor of the origin of granite at enormous depths, as it is difficult to see how both can be true.

Mr. H. C. Sorby has led the way in studies of the mineral constituents of eruptive rocks. He measures the included cavities in the component minerals, and calculates how much the contained substances must have contracted in cooling, allowing for an increase in the temperature of the point of vaporization under pressure. By assuming the temperature to be correctly determined, he ascertains the amount of pressure indicated by mathematical formulae, and finds it to be the equivalent of a thickness of 40,000 feet of overlying rock in Cornish granites, and of 60,000 feet in Scotch granites. Later writers seem to have regarded this pressure as certainly produced in the way thus suggested, and that its appearance at the surface has been due to an enormous erosion which has denuded the overlying blanket. This conclusion is not necessary; for, 1°, an enormous pressure would result from the tangential force of contraction, which would be entirely adequate to have produced the cavities. 2°. The necessity of an erosion of 40,000 feet over all the granites in every part of the world cannot be maintained. In North America, for example, it would necessitate the supposition that nearly eight miles' thickness of rock had been removed from one-fourth of the surface since the Laurentian, for the blanket removed would have equalled in dimensions the crystalline areas. The mere statement of the amount of denudation required refutes the theory. 3°. By reference to existing volcanoes, it is plain that a column of lava will often be adequate to exert the needed pressure. Teneriffe rises 12,000 feet above the ocean, and its cone descends 18,000 feet more to the submarine plateau. When the crater is full of melted lava, there must be a pressure of 30,000 feet at the base of the cone: hence the lava from the reservoir supplying Teneriffe might exhibit the vacuities produced by a pressure of 30,000 feet without any weight above the peak.

When molten lava pours down the side of a crater, the included vapors and liquids must disappear because of the removal of the pressure; but, after a substantial crust has formed, the peculiar markings imprinted at the great depth would remain: hence we can understand how it is that the vacuities are to be seen both in granites and lavas that have been subjected to great pressure. At the Boston meeting of this association I endeavored to show that there are mountain masses of granite in New England possessing all the physical characteristics of volcanic cones. The material must have been liquid, hot, ejected from a vent, and flowed over a plateau, building up a cone, and indurating the underlying floor. It was claimed that such phenomena could be explained only by supposing the granite to have been erupted just like lava. This granite contained the usual vacuities indicative of great pressure just as they are also found in the lava of Monte Somma or the trachyte of Ponza.

When one examines the interior structure of modern lava-flows, he is surprised to find beds nearly as well defined as the foliation of schists. Around vents like Vesuvius or Etna the lava accumulates naturally in quaquaversal sheets, no one eruption being very extensive. When steam and hot water are copiously supplied from the caldron, there may be flows of hot mud and tufa. The closing phases of eruptions are usually showers of ashes falling upon the cone or beyond. If the vent is beneath the ocean-level, the lava is minutely subdivided and the deposit will be like sand or gravel. Between the igneous flows the ordinary aqueous agencies will wear off excrescences, and scatter the fragments down the slope. These various agencies will produce a concentric stratiform arrangement in the whole mass. Where the eruption is massive, a similar set of layers will be formed.

This mass of volcanic material will be very susceptible to metamorphic influences when placed under the proper conditions of heat and pressure. As the result, new minerals will be formed, arranged in foliated beds or schists. Thus briefly stated may be the origin of foliation. So long ago as 1825, Poulett Scrope advocated essentially this doctrine for the arrangement of the crystalline particles in the crystalline schists, having found an analogous structure in certain volcanic accumulations.

Sufficient has now been said in advocacy of our doctrine that the first land consisted of volcanic islands. This was the Laurentian or azoic accumulation. Cartographers have not yet distinguished the several crystalline deposits, so that it will not be practicable at present to point out the supposed volcanic areas of the Hastings, Grenville, Montalban, Huronian, and other eozoic periods. Sedimentation would also act so that in this age many beds must be referred to an aqueous derivation. By the close of the eozoic the continent was outlined; or at least the framework of the future superstructure was put into position. The broader patches about to be mentioned had their origin in the earlier numerous islands cemented by detrital accumulations.

The more important areas developed in the eozoic must have been Greenland, Canada east of Lake Winnipeg, the Atlantic district, the Rocky Mountains, the Sierra Nevadas, and numerous buttes over the Cordilleras. The three great depressions of Hudson's Bay, the Mississippi valley, and the Salt-Lake and Nevada basins commenced to sink very early, and the future growth of the continent consisted largely in filling them up with marine sediments. An inspection of a map drawn upon a correct scale will dissipate the fancied resemblance to the letter V, in the Canadian dominion, so often insisted upon. Neither has the development of the land been in bands parallel to the north-west and south-east arms of this supposed angle. A better conception would find three great basins, excluding the unknown regions of Mexico and Alaska, in each of which operations were conducted independently. The best known is that of the interior of the United States, or the Mississippi hydrographic basin. This depression was nearly encircled by a crystalline border of high land. Beginning at Alabama, we follow it to New England, thence by a slight gap to the Adirondack promontory, thence across the Lakes to the Dakota promontory. In Minnesota and Dakota the schists are more or less covered by cretaceous clays and tertiary sands; but they evidently constitute the floor for the surface strata occasionally piercing through the later deposit, as in the Black Hills. Thus we may connect the Dakota and Rocky Mountain crystallines. From Wyoming southerly the granites are again conspicuous into New Mexico. Thus the circuit is not complete: it is like a horseshoe, with the lower Mississippi valley in the gap; yet this may have been filled in the Cambrian age, since Laurentian islands are found in Texas, Arkansas, and Missouri. We might give reasons for believing in the recent origin of the depression between New Mexico and Alabama.

The map will show, around the borders of this Mediterranean Sea, the primordial sea-beach, whether examined in Virginia, New York, Michigan, Colorado, or Texas. Could we dissect the land, we should find an immense platter of Cambrian sediments coextensive with the crystalline highlands surrounding and underlying it. In Cambro-Silurian times the story is repeated. Marine limestones formed other dishes, each limited in size by the upturned edges of the platter underneath. The rest of the history is given in our text-books. Our Mediterranean Sea was not closed till the end of the cretaceous, when the salt-water was expelled, never to return.

In the west a similar ovoidal, crystalline border can be traced, holding paleozoic sediments. Beginning at the Rocky Mountain chain in Wyoming, we follow it southerly to Mexico. Across Arizona are many gneissic outlines, but not sufficiently numerous to close the gap. In California we reach a country entirely gneissic beneath the sands of the desert, which connects with the Sierra Nevadas, and is traceable along the Nevada line nearly to Oregon. There the course is changed, the rocks trend north-easterly, show themselves conspicuously in the Blue Mountains of eastern Oregon, the Salmon River Mountains of Idaho, and western spurs of the Rockies again in Montana, which are continuous to our starting-point in Wyoming. Our crystallines do not pass north of the parallel of 49° into Columbia. We have therefore found a complete crystalline border for the depressions of our western territories, and, within this ovoidal line, all the members of the paleozoic, mesozoic, and cenozoic groups, but not arranged with the simplicity of their distribution in the east.

Less is known of the arctic basin than of the others; but the scattered sketches afforded by voyagers indicate the presence of the more important members of the geological column. Where these basins adjoin, there is a much wider area of ancient land.

In conclusion, I will simply recapitulate the more important phases of the growth of our continent.

We start with the earth in the condition of igneous fluidity.

It cools so as to become incrusted and covered by an ocean.

Numerous volcanoes discharge melted rock, building up ovoidal piles of granite, which change gradually into crystalline schists. When these hills are high enough to overlook the water, they constitute the beginnings of dry land.

At the commencement of paleozoic time the continent is composed of three immense basins, located near Hudson's Bay, the Mississippi hydrographic area, and the great Nevada series of land-locked valleys.

The later history of the development of the continent presents the details of the filling-up of these depressions, the expulsion of the Mediterranean seas, and the description of the varied forms of life that successively peopled the land and water.

The history opens with igneous agency in the ascendant. Aqueous and organic forces became conspicuous later on, and ice has put on the finishing touches to the terrestrial contours. The completed structure we must acknowledge to be 'very good.'

NOTES AND NEWS.

Our leading article of June 29 was based in part upon a mistake, which we desire to correct. Foreign periodicals received by mail in single numbers have not been dutiable within the last five years. Nevertheless, the writer of the article, who subscribes to three foreign scientific journals, and receives them by mail, had been forced to pay duty on each number for the past nine or ten months; and the same has been the case with others of our acquaintance. Our post-office regulations are so frequently changed that one can rarely tell whether he is the victim of a blunder or a whim.

—M. Pasteur, who has just obtained a grant of fifty thousand francs from the French Chambers to send a scientific mission to Egypt to investigate whether the cholera be not due to the development of a microscopic animal in the human body, states, in a letter to *Voltaire*, the reasons which induced him to recommend the board of health to send out the mission in question. He says, "I urged the sending-out of this mission on account of the great progress that science has made since the last cholera epidemic respecting transmissible diseases. Every one of these diseases that have been the subject of a thorough investigation has led biologists to the conclusion that they were caused by the development, in the body of man or the animals, of a microscopic animal, causing therein disturbances frequently fatal. All the symptoms of the disease, all the causes of death, are directly under the influence of the physiological properties of the microbes. What is needed at present to meet the requirements of science, is to ascertain the primary cause of the scourge. Now, the present state of our knowledge indicates that we should direct all our attention to the possible existence in the blood, or in such or such an organ, of an infinitesimally small being whose nature and properties would in all likelihood account for all the peculiarities of cholera, both as regards its morbid symptoms and the mode of its propagation. The existence of that microbe once ascertained would speedily settle the question as to the measures to be taken to check the spread of the disease, and might possibly suggest new therapeutic means to cure it." The mission consists of four young *savants*, doctors, and biologists, — Drs. Roux, Thuillier, Straus, and Nocard. M. Pasteur hopes, that, by scrupulously attending to the hygienic precautions he has written down for them, the great danger they are incurring may be minimized.

— The September *Century* has several papers to which our readers' attention may be called. One of the illustrated articles relates Lieut. Schwatka's personal adventures in the hunt for the musk-ox. Ernest Ingersoll gives an excellent account of Mr. Agassiz' private laboratory at Newport, and of the methods he has so successfully introduced for carrying delicate sea-animals through their earlier stages. An admirable portrait, engraved by Velten, from a photograph of Notman's, will interest many. It has more spirit than one formerly published in the *Harvard register*. Under the title, 'The tragedies of the nests,' John Burroughs writes of the difficulties birds encounter in rearing their young. The attempts toward the unification in railway time in this country are briefly discussed by W. F. Allen.

A writer on ornamental forms in nature gives several striking illustrations of the effects producible, with due study, by 'the naturalistic school' of decorators. With eyes capable of seeing the stream, moth, vine, and skunk-cabbage 'in nature' as they appear to our writer, we may doubt the possibility of their evolutionary limit in art being ever reached. Like the Spanish-Moorish designer, he 'evidently did not care three straws for what all the botanists and florists on earth might think of his work,' so long as it teach us to regard nature from the standpoint of art, and tend in some measure to straighten the devious paths of the modern conventionalizer.

— The *Tribune* of Minneapolis, for Aug 16, printed Dr. Dawson's address before the American association in full, as well as long abstracts of several of the sectional addresses. Subsequent issues gave very fair reports of the papers read.

— The first number of Kobelt's *Iconographie der schalentragenden europaischen Meeres conchylien* has appeared. It is in quarto, with colored plates, and this number is devoted to species of Muricidae. The descriptions are in Latin, with German text.

— The Washington, of the Italian navy, under command of Capt. Magnaghi, is engaged in its annual cruise for the study of the western Mediterranean.

— One of the Akkas (African pygmies) taken to Italy in 1873 by Miani has just died of consumption at Verona.

— The newspapers of yesterdav announce that Mr. J. A. Ryder has succeeded in rearing the American oyster from the egg. His experiments were made in natural enclosures, and so conducted as to preclude any doubt that the spat obtained has been derived from any source except that of the spawn artificially fertilized and introduced into the enclosure. The greatest obstacle to the cultivation of the oyster is now removed.

RECENT BOOKS AND PAMPHLETS.

Delogne, C. H. Flore cryptogamique de la Belgique. livr. 1.: mousses. Bruxelles, 1883. 8°.

Delpino, F. Teoria generale della fillotassi. Genova, 1883. 345 p. 4°.

Depérais, C. Hygiène publique: nouveau traitement des cadavres ayant pour but la destruction des germes contagieux qu'ils peuvent contenir. Naples, *Inst. roy. d'encouragement*, 1883. 19 p., pl. *autogr.* 8°.

Drinker's Explosive compounds and rock drills. Forming a supplementary volume to the first edition of Drinker's Tunnelling. N.Y., 1883. 4°.

Duclaux. Microbiologie. Paris, 1883. 908 p., 111 fig. 8°.

Gerland, E. Der leere raum, die constitution der körper und der aether. Berlin, 1883. 8°.

Grindon, L. H. The Shakspeare flora. Guide to all the principal passages in which mention is made of trees, plants, flowers, and vegetable productions. With comments and botanical particulars. Manchester, 1883. 330 p. 8°.

Henrivaux, J. Le verre et le cristal. Paris, 1883. atlas, 26 pl. 8°.

Heriz, E. Construcción de mapas. Barcelona, *Ramirez*, 1882. 12 p., 8 pl. 4°.

Herrmann, G. Der reibungswinkel. Aachen, 1883. fig. 4°.

Heukels, H. Schoolflora van Nederland. Bewerkt naar O. Wünsche's Schulflora von Deutschland. Groningen, 1883. 62+368 p. 8°.

Israels, A. H., en **Daniëls**, C. E. De verdiensten der hollandsche geleerden ten opzichte van Harvey's leer van den bloedsomloop. Utrecht, 1883. 143 p. 8°.

Jordan, D. S., and **Gilbert**, C. H. Synopsis of the fishes of North America. Washington, 1883. 1,018 p. 8°.

Jordan, W. L. New principles of natural philosophy. London, 1883. illustr. 8°.

Koehler, R. Recherches sur les echinides des côtes de Provence. Marseille, 1883. 167 p., 7 pl. 4°.

Kohlfürst, L. Die elektrischen einrichtungen der eisenbahnen und das signalwesen. Wien, 1883. (elektro-techn. bibl., xii.) 288 p., illustr. 8°.

Lambert, E. Traité pratique de botanique. Propriétés des plantes, leur utilité et leur emploi dans la médecine, l'industrie, etc. Paris, 1883. illustr. 8°.

Larden, W. School course on heat. N.Y., 1883. 321 p., illustr. 8°.

List of British birds. Compiled by a committee of the British ornithologists' union. London, 1883. 258 p. 8°.

Lubbock, J. Fourmis, abeilles et guêpes. Études expérimentales sur l'organisation et les moeurs des insectes hyménoptères. 2 vols. Paris, 1883. illustr. 8°.

Mann, L. Die atomgestalt der chemischen grundstoffe. Berlin, 1883. illustr. 8°.

Martini, A. Manuale di metrologia, ossia misure, pesi e monete in uso attualmente e anticamente presso tutti i popoli. Torino, 1883. 912 p. 8°.

SCIENCE.

FRIDAY, SEPTEMBER 7, 1883.

FRANCIS MAITLAND BALFOUR.

About a year ago came the sad news of the sudden death of Professor Balfour of Cambridge. If the loss was felt less severely in this country than in England, it was only because he had fewer personal friends here; and to fully understand his worth one must have known and talked with him. It is true that it required no unusual insight to read the fine qualities of the man in his writings; but none save those who knew him could appreciate his remarkable personal attractiveness. Not the least part of the wonderful work of his short life was that which he accomplished as a teacher: here as everywhere, his personal influence had a large share; and a sketch of Balfour's scientific work would be incomplete without a recognition of the bearing which his noble character had upon it.

The meeting of leading biologists in October last, to found the Memorial studentship, was remarkable in many ways: rarely have been heard such words of admiration and love for one man as were then expressed for Balfour. Many spoke at length of the debt Cambridge owed him. It may be said that he divided with Foster the honor of giving the great impetus to the biological movement in the English universities. What Huxley had done for Foster, the latter did for Balfour, giving him the first hearty encouragement and support; together they raised biology from the third to the level of the first rank of studies at Cambridge, equalling that held by mathematics. Oxford soon followed this important movement, trying to secure Balfour for the professorship left vacant by the death of Rolleston. His connection with natural science at Cambridge was described in warm language by Foster, his teacher, and by Sedgwick, one of his pupils: he advanced morphology there by his brilliant success in teaching and in research.

In teaching he combined manly force with a delicate regard for the feelings of his pupils. From the writer's personal impressions of him as a lecturer, he did not aim at eloquence, but to be understood in every step; rarely looking at his hearers, he spoke rapidly and with intense earnestness, crowding a vast deal into the hour. The main qualities of his character shone forth in his lectures, — energy, which he infused into his hearers; truthfulness, which soon gave implicit confidence in his statements; modesty and sympathy, which inspired effort and free exchange of thought.

Balfour's love of truth came constantly into play in his laboratory instruction. While looking over a student's shoulder, he would sometimes say with a laugh, "You must interpret that specimen with the eye of faith;" but this was very far from being a serious injunction, for he exacted of his students the greatest caution in the progress of their microscopic work. However tempting a certain interpretation of a specimen might be, Balfour never accepted it until it rested on the clearest evidence. An instance of this sort is recalled by the writer, which related to the much disputed origin of a well-known embryonic structure. A number of sections had been prepared, seeming to confirm the view which Balfour himself had advocated some time before; it required considerable self-control not to attach a somewhat forced meaning to them: this was, however, forbidden; and it was not until several days afterwards that fresh sections established the fact beyond question.

To Foster, Balfour repaid his student-debt by extending, in turn, continued encouragement to others. He did not fear, as many great teachers have, that joint labor with his juniors would derogate from his reputation: his joint articles are numerous; he was zealous to recognize research done by his pupils, seeming to be prouder of this than of his own work. Nothing could be more stimulating to the young men about him, still distrustful of their powers, than this generous co-operation. Is it surprising, then, that the voluntary attendance upon his lectures increased in seven years from ten to ninety, and that at the time of his death twenty students were engaged in difficult research in his laboratory? Only those who are familiar by experience with the few incentives among younger students to the study of biology can appreciate what these numbers mean.

We need not attempt to give a full list of Balfour's writings. They began in 1873, his twenty-first year, with a few short papers appearing over Foster's name and his own in the *Quarterly journal of microscopical science:* they terminated nine years later, with his fine work upon Peripatus, published posthumously in the same journal, and of which a full abstract will be found farther on. His extensive intermediate works, the Elasmobranch fishes and Comparative embryology, are universally known.

From the first he devoted himself to embryology. While this, as among the youngest of the biological sciences, admits of rapid work, it is far from admitting rapid generalization. No other branch of morphology requires more painstaking; the very materials one has to study are minute and indefinite; and two minds will often place different constructions upon the same specimen. There is abundant opportunity for scientific guesswork, with the feeling of security that disproval will be difficult. Balfour understood the real value of guessing at truth, but he always made it very clear to the reader when he was so doing; his hypotheses were accompanied by definite statements, in which the reasons *pro* and *con* were set forth in all impartiality to each. Herein lies a chief charm and merit of his work, its brilliant suggestiveness, side by side but never in confusion with well-established facts. Every chapter contains half a dozen invitations to other investigators to prove or disprove certain provisional statements. Vast as is the information contained in his Comparative embryology, Balfour himself appreciated, that, as far as mere facts went, the first volume would be somewhat out of date before the second was in press. Not so, however, with his masterly discussions of these facts, which are found on every page, and the value of which, to embryologists, cannot be estimated. Moreover, to his authorship is largely due the rapidly spreading interest in embryology in England and America, — a branch of science, it will be remembered, which had previously been mostly in German hands.

One frequently heard from him his own very modest opinion of his work; this was not at all inconsistent with striking independence and originality of thought, and adherence to his convictions. His modesty added more to the recognition of his genius than any assertions of his own could have done. Many were pressing forward to assert his claims, and honors were fast showered upon him in England and abroad. He was admired and beloved by all who knew him. In scientific discussion he had the rare quality, which Richard Cobden is said to have possessed, of remaining on the pleasantest personal terms with his opponents.

His energy in all matters was great, and his power of writing was unusually rapid; but, advised by kind friends, he rarely overtaxed his strength, which was limited. He spent most of his evenings with his friends, throwing off from his mind the labors of the day, and talking vivaciously upon the topics of the times. When the first volume of Comparative embryology was being written, he generally worked but five hours daily, giving much time to physical exercise, bicycling, or tennis, into which he entered with all the enthusiasm of his nature. He was courageous, but not reckless; and nothing in his previous life would lead us to suppose that the mountain climb which proved fatal was undertaken in a foolhardy spirit.

Balfour in a few years accomplished the work of a lifetime. His influence was and is twofold, — first, upon those with whom he came in personal contact, especially his scientific associates and students (an influence which cannot fail to endure, well expressed by Professor Kitchen Parker: "I feel that his presence is still with me; I cannot lose the sense of his presence"); and, secondly, the influence of his scientific work, which for genius, breadth, and truth, can never be surpassed. May the splendid memorial which has been raised for him perpetuate his noble example as a teacher and man of science! Henry F. Osborn.

THE INTELLIGENCE OF BIRDS.

Having met with many instances wherein birds have shown considerable ingenuity in overcoming the ill results of accidents to their nests, such as often arise during violent storms, it occurred to me, at the outset of the bird-nesting season of the present year, to endeavor to test their intellectual powers generally, by a series of simple experiments, hoping thereby to be able to determine to what extent birds exercise their reasoning faculties.

My experiments, and the inferences I drew, are as follows: —

Noting the material being gathered for the nest, partially constructed, of a chipping-sparrow (Spizella socialis), I placed a small quantity of the same in a conspicuous position near the nest. It was seen by the sparrows, and examined, but none was removed. I placed a portion of it upon the margin of the unfinished nest: it was promptly removed by the male bird, who used only such materials as were brought to him by his mate. The following day the task of lining the nest with hair was commenced. I placed a quantity of this material on a branch near by, but it was passed unnoticed. I next placed a few hairs on the margin of the nest: they were promptly removed. On replacing many of these in the nest, the entire lining was thrown out. I replaced it, and the nest was abandoned.

A week later, finding another nest with three eggs, I added a few white cat-hairs to the lining: these were removed. Others of dark colors were added: they, also, were removed. I replaced both dark and white hairs: the eggs were broken, and the nest abandoned.

Four eggs found in a third nest were removed without touching the nest, a wooden spoon whittled for the purpose being used. In three days the female commenced laying again: four days later three eggs had been laid. Replaced the four I had removed: they were promptly thrown from the nest. I then removed the nest, and, substituting another, carefully replaced the eggs without handling them. After what appeared to be a serious consultation, the new nest was accepted.

These birds suffered no further annoyance, and reared their brood without mishap.

Why should not these have utilized the material for their nest which I offered, rather than gather similar stuff from distant points? They could not have been frightened by any odor attached to the material through handling, as I was careful not to touch a particle of it, using a pair of wooden tweezers in every case. Neither did they see me carrying any thing to or from their nests. As these, in all cases, were nearly or quite completed, the birds had necessarily become thoroughly familiar with the surroundings, and doubtless recognized the fact that these offered twigs and the hair had suddenly appeared in, to them, some unexplained manner, and the mystery surrounding it made them suspicious. Suspicion, I suggest, is a complicated mental effort. Again: the sparrows were sorely perplexed when a nest not of their building, but of the same character, was substituted for their own. Here, these birds exhibited fear; but finally the maternal instinct overcame the timidity of the female, and she resolved to brave the danger or solve the mystery, and cared for her eggs as usual. The male bird kept aloof for several days, I think; but of this I am not positive. These sparrows were moved by conflicting emotions, — evidence, I think, of an advanced degree of intelligence.

Another series of experiments were as follows: finding a nest of the summer warbler (Dendroeca aestiva) in a low alder, the foliage of which was about one-third grown, I girdled the supporting growths a few inches below the nest. The leaf-buds withered, and the nest, which under ordinary circumstances would have been quite concealed from view by the full-grown leaves, was now exposed. The nest was abandoned.

The next girdling experiment was made on the nest of a white-eyed vireo (Vireo noveboracencis) found attached to a low limb of a small beech. The leaves quickly shrivelled, and the nest, although just finished, was abandoned.

A second experiment of the same sort was tried, with identical result.

A nest of the summer warbler was found in a low shrub, containing young birds, and the supporting branches girdled. The leaves withered and fell, exposing the nest to full view. The parent birds remained, and successfully reared their brood.

In these cases we have evidence of mental operations of a more complicated character than any exhibited by the sparrows. It is evident, that in every case, these birds, in selecting the position for their nests, knew that the growth of the foliage would afford a desirable, if not necessary, protection to them. Finding that the growth of the foliage had been checked, that the little shelter at first afforded was daily growing less, they foresaw that the nests, under these circumstances, would be too much exposed to be safe from molestation, and they were abandoned, even after a full complement of eggs had been laid. Can we explain this by any other means than by using that very suggestive term 'foresight'? But mark: when the same circumstance occurred after the young had appeared, the claims of the brood upon the parents were too strong to be overcome, and the danger of occupying an exposed nest was readily braved.

Experiments of another character were as follows: I placed a series of short pieces of woollen yarn, fastened together at one end, near the tree containing a partially constructed nest of a Baltimore oriole (Icterus Baltimore). These yarns were red, yellow, purple, green, and gray. An equal number of strands of each color were thus offered to the orioles as building-materials. I purposely placed the red and yellow strands on the outside of the tassel-shaped mass, so that these would be first taken, if the color was not objectionable. To my complete surprise, the gray strands only were taken, until the nest was nearly finished, when a few of the purple and blue yarns were used. Not a red, yellow, or green strand was disturbed. Here we have an instance of the exercise of choice, on the part of a bird, which is full of interest. The woollen threads being otherwise identical, it was the color only that influenced the choice of the birds: they realized that the red or yellow yarns would render the nest conspicuous, although well protected by the foliage of the branch to which it was attached. Why the green threads were not taken I cannot imagine. As a result of this experiment, I anticipated that the orioles would reserve the brightly colored yarns for the lining of the nest, and the gray and green for the exterior. This was a result obtained two years ago, when I tried a similar experiment; but the use of red yarn as a lining may have been merely accidental.

Out of mere curiosity, for I could not anticipate what might be the result, I made a few transfers of the eggs of one species into the nest of another bird. The results were not, however, particularly suggestive. I placed the eggs of a cat-bird (Mimus carolinensis) in the nest of a song-thrush (Turdus mustelinus), and *vice versa*. The eggs of the former are dark green; of the latter, light blue. No act indicative of recognition of the change was observed. I placed eggs of the song-sparrow (Melospiza melodia) in the nest of a pee-wee (Sayornis fuscus), and *vice versa*. The fly-catchers rejected the eggs of the sparrow; but the latter accepted the situation, although disturbed by it. Many other changes were made, with similar results; and I concluded, that, unless the eggs were greatly different in size and color, about one-half would be accepted; but, when a single egg was placed in the nest of another bird, it was destroyed in nearly every case. This I found to be true, even when I tested such birds as are subjected to the annoyance of the cowpen bird's egg being deposited in their nests. I was surprised at this result, and am led to believe that large numbers of the eggs of this bird are destroyed. It is well known that our summer warbler frequently outwits the cowpen bird by building a new nest directly above the old, — a two-story nest, in fact, — and leaves the egg that has been left to her care to rot in the basement, while she rears her young on the floor above. It will be seen that from these experiments no very positive results were obtained. I did note, however, that, where the change was accepted, it was not because it passed unnoticed, but was submitted to, notwithstanding the evidences of much misgiving on the part of the birds. In one case, the nest was practically deserted for twenty-four hours, and the eggs were chilled in consequence. The birds sat upon them for five days, when, as they did not hatch, the nest was abandoned. In previous years I have made these changes occasionally with success, but was not able to determine that the young were recognized as not the offspring of the parent birds. In such cases the young were tended with the usual care up to the time for leaving the nest. This may possibly be indicative of stupidity. It appeared so to me at the time; but I am now disposed to see in it an indication that the maternal instincts here, as in other cases I have mentioned, overcame all other feelings, and that the fact was accepted by the birds with as good grace as they could command.

The co-operation of birds, when constructing their nests, is a subject that demands a good deal of close attention, and is one surely worthy of more systematic observation than has as yet been given it. The many ways in which birds assist each other in nest-building offer, perhaps, the clearest evidence that they have a very intelligent notion of what they are doing, or propose to do. I feel warranted at the outset in making the somewhat startling assertion, that the choice of location for a nest is made only after protracted joint examination of suitable sites, and is the choice of both birds. I doubt if it ever happens that one of a pair of birds 'gives in' to its mate. Certainly such a thing as madame giving up to her lord is unknown in the bird-world. My impression is, that the female birds of every species are exacting, obstinate, and tyrannical. I have seen marked instances of this among house-wrens, pee-wees, and even known a cooing turtle-dove to exhibit unmistakable evidences of a quick temper. These may seem to be trivial matters, and not within the range of the scientific study of animal intelligence; but it is an error to look upon such proofs of individuality in this light: they are among the most convincing evidences of a high degree of intelligence. If a hundred or more nests of the same species of birds are carefully compared, it will be found that there is a considerable range of variation in their construction, and a varying degree of merit in the skill shown by the builders. Is not this evidence of different degrees of mental strength occurring among birds of the same species?

But to return to the subject of co-operation in nest-building. I have found, that where very long, fibrous materials are used, as in the case of the globular nests of the marsh-wrens, the birds work together in weaving the long grasses that form the exterior. I have seen one of these birds adjusting one end of a long blade of rush-grass, while its mate held the other end, until the former had completed its task to its satisfaction. It was evident that the weight of the ribbon-like growth that the bird was using, quite a metre in length, was too heavy to be moved to and fro, and at the same time prevented from slipping from the unfinished nest. Only by assistance could such materials be utilized, and only by intelligent joint labor could these little birds build such large and complete globular nests. Many birds, too, have been known to jointly carry away a long string or piece of muslin too heavy or cumbersome for either one to move. Again: materials are often brought by one of a pair of birds to a nest which the other considers unsuitable, and fierce quarrels often arise from this circumstance. In such cases we have instances of a difference of opinion among birds, which is a marked indication of mental activity.

Charles C. Abbott, M.D.

THE IGLOO OF THE INNUIT.[1]—IV.

The interior of an igloo can be best understood by reference to the diagrams. The one, fig. 1, is a vertical section through the entrance; and the other, fig. 2, a ground-plan. Directly opposite the entrance is raised a platform of solid snow, eighteen inches to two feet in height, which takes up about two-thirds of the floor; and on this are spread the reindeer-skins which make the bed. Sometimes, if the party be large and but one igloo built, there are two of these snow-beds, separated by a narrow aisle running from the entrance; the persons then sleeping at right angles to the positions shown in the illustration. But such large igloos are rare, unless of a permanent or semi-permanent character. On an extension of the platform forward, on the woman's side, is placed the stone lamp; and here the food is cooked, and the native skin clothes are dried. The height of this platform or snow-bed is nearly always above the top of the low door; for the Innuits are instinctively masters of the simple laws of pneumatics, and try to keep the snow-bed as high as possible to reach the upper or warmer strata of air, especially to keep higher than the cold air, which can come in through the open door. The height varies with the permanency of the abode, the temperature, and with the tribe. If very cold, or if intending to occupy the igloo for some time, the beds are made higher than they would be otherwise. The Netschilluks and Kinnepetoo always make much higher beds than the Iwilliks or Iglooliks. There is also much variation in the flatness of the dome; those of the former tribes, especially the Netschilluks, being very flat. This, with their high beds, makes the space between them very small; but in compensation their igloos are the warmest and most comfortable in the whole arctic region. These Netschilluks (in and around King William's Land) nearly always have to jump out in front of their beds to get standing-room to dress in, although all Innuits are adepts in the art of putting on the most intricate clothing in the smallest space conceivable.

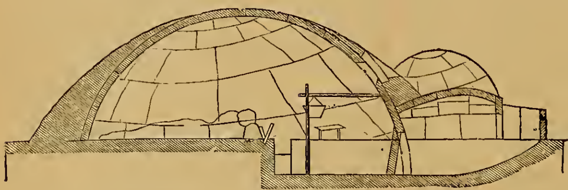


Fig. 1.

The Kinnepetoo Innuits (around Chesterfield Inlet, especially north of it) use few or no lamps to warm their snow-huts, and, despite the high beds and low roofs, they are cold, cheerless, and uncomfortable beyond measure. These Innuits are essentially reindeer killers and eaters, and lay in an insignificant stock of seal-oil to burn in their lamps. Walrus-killing is unknown to them. For light they use a piece of rendered reindeer suet, laid beside a piece of lighted moss, all being on a large flat stone. The light of the stone lamp in all igloos where it is used is sufficient for all purposes of sewing and repairing. It is certainly equal to the light from three or four kerosene-lamps, and, with the white snow-walls, gives ample illumination.

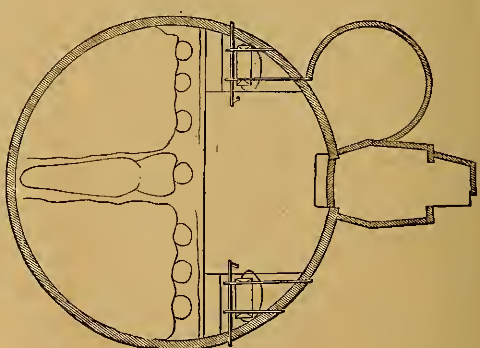


Fig. 2.

The Oo-quee-sik Salik Innuits (around the mouth of Back's River), who are salmon-eaters, are another tribe that dispense with warming the snow-houses for want of oil; and this with their very poor stock of clothing, they being

[1] Continued from No. 30.

almost constantly in rags, makes them a most forlorn, uncomfortable-looking, and dejected lot of human beings. The powers of these two tribes to withstand the cold seem almost phenomenal.

The flatness of the domes, however, is not wholly a tribal peculiarity, but is also a function of the season of the year. In the wintertime, when the snow is hard and compact, the roof can be made much flatter than in the spring, when the warm, sunny days bring on a thaw, and threaten to tumble it in. At such times it is made very peaked, to gain strength for its weakest points, the inclining blocks.

The Iwilliks and Iglooliks (among the estuaries of North Hudson's Bay) have ample supplies of whale, seal, and walrus oil, and, despite their higher roofs, have very comfortable houses in the way of warmth, while they exceed all others in roominess, and ease and comfort in dressing and undressing.

The heated air, of course, rises to the top; and, should it grow too warm inside, this heat soon cuts its way through the joints of the top blocks, and enough fresh air enters to quickly reduce the temperature below freezing again, especially if it be very cold on the outside. Sometimes this ascending heat makes so much impression on the edges of the top blocks that they commence to thaw and drip in an annoying manner. This is always remedied by taking a handful or a small block of snow from the floor, where the temperature is very low, and applying it to the dripping spot, where it freezes immediately, and, like a sponge, absorbs the drippings. These little pests have to be watched closely, however: for when they are saturated with water, and thawed from their frozen fastenings, they will come down like a slushy ball of lead; and it seems as if they would defy all the laws of gravity to get down a person's back, or hit a sleeper in the face. I once had a large one fall in a pint cup full of hot reindeer-soup just as I had it near my nose, blowing it to hurry up the meal and get away from a delayed camp.

Small store-igloos are built outside to hold the bulky material, and often connect with the main igloo or its entrance, if their contents are needed from time to time.

Where several families, generally related, build a family igloo, it is done by making a large central one, without bed-platforms or other impediments to roominess; and around this are built the smaller family igloos, — two, three, or even a half-dozen, — connecting with the central one by high groined arches that will generally allow of passing from one to the other without stooping; and conversation can be readily carried on between them, these smaller igloos being more like radiating alcoves than separate structures. Then the entrance to the main part is made very long (fifteen or twenty feet), and its outer end is changed from time to time to face *away* from the wind, if it be at all strong. The usual entrance is so low that one always has to enter on his hands and knees; but in these family igloos the greater part one can accomplish by stooping considerably. There is always a crowd of hungry dogs ready to take advantage of a person's entering to crowd in close behind, so as to steal a stray piece of blubber from the lamp-platform or floor. At all other times two or three of their heads can be seen closing the entrance, waiting a good opportunity for a dash. The matron of the house, sitting *à la Turc* on the edge of the bed, keeps a good stout club convenient, and whacks them over the nose whenever they make an unusually impudent intrusion. At night-times, and during cold, windy weather, the more belligerent of these camels of the cold monopolize the entrance for sleeping-apartments; but they generally manage to get into some sort of fight, breaking in the door, and the master then arises and vacates these canine compartments with the butt-end of a whip or a sledge-slat, and they remain quiet for the rest of the night.

The temperature inside ranges from freezing (above which, of course, it cannot ascend) to about ten to twenty degrees below. Late in the winter, when all have inured themselves to the cold, the same tribe will keep their houses much colder with the same apparent comfort. At these temperatures one feels very warm after coming in from the outside. The outer clothes are taken off, and even baths are indulged in; the little children, *stark naked*, playing on the reindeer-skins of the bed with the little puppies and toy harness. Those tribes that do not use oil-lamps are, of course, much colder in their houses, having only the warmth of the body and a few lights, with occasionally some cooking from the lamps; yet I do not think it ever gets below zero. Even in these igloos I have known a Kinnepetoo to take a reindeer-skin that had been soaked to rid it of hair, and that was apparently frozen as solid as boiler plate iron, and, putting it under his coat against the bare skin, hold it there not only until it was thawed out, but also until it was dry, and fit to be used for a drumhead for their superstitious rites. Juggernaut could show no greater devotees among his followers. Such are the iron Innuits of the unwarmed igloos of the Arctic.

A recently constructed igloo is more comfortable than one long used, the alternating heat and cold of the day and night soon converting the latter into a translucent mass of ice, that becomes uncomfortably chilly on a cold night; besides, the steam from the cooking and the moisture from the breath congeal upon the roof, and, in the course of ten or twelve days, become so thick as to form a base for a constant liliputian snow-storm, which is disagreeable beyond measure. One of the most conspicuous comforts of arctic travelling is the constant changing of igloos.

(*To be continued.*)

BALFOUR'S LAST RESEARCHES ON PERIPATUS.

At the time of his death, the late lamented Prof. F. M. Balfour was engaged upon an investigation of the anatomy and development of Peripatus, the lowest known form of Tracheata (insects). Unfortunately, he left his work far from complete; but two friends, Mr. Sedgwick and Professor Moseley, both thoroughly competent, have undertaken and completed the grateful task of editing what could be gathered from Balfour's material. We have, however, hardly more than a descriptive account of the anatomy and development of the animal. We miss the fruitful thought with which Balfour enriched his writings before committing them to the press.

The article is published in the April number of the *Quarterly journal of microscopical science*, and is accompanied by numerous beautiful plates. A portion of these were drawn by Miss Balfour. Their excellence graces this quiet expression of a sister's close relation to a gifted brother.

Balfour's investigations were directed especially upon Peripatus capensis. The memoir opens with a careful description of the external characters of the species. The account of the legs is the first satisfactory one published. The number of legs is variable, but usually there are seventeen pairs. Each leg has the form of a cone, with a pair of claws at the apex: it bears a succession of rings of papillae, but towards the tip the papillae in part fuse together to form three ventrally placed pads. The foot is distinct, being separated by a constriction from the upper part of the limb, and has several pads upon its ventral surface, and bears the two conical recurved claws. On the middle of the ventral line of junction of the leg with the body lies the opening of the segmental organs. The disposition of this opening on the fourth and fifth legs is slightly different. The last leg has a papilla with a slit-like gland opening at its apex. The gland itself is large, and runs far forward, and is probably a modified crural gland.

Part II. is a monograph of the internal anatomy. In the *alimentary canal*, a nearly straight tube slightly longer than the body, five parts may be distinguished. 1. The buccal cavity. Its opening is surrounded by a tumid lip, covered by a soft skin raised into papilliform ridges. Attached to the median dorsal wall of the cavity is a muscular protuberance (tongue), covered by the oral epithelium, and furnished with organs of special sense, like those in the skin, and with chitinous teeth. On each side of the tongue is placed the jaw, with recurved chitinous teeth. The jaws are, no doubt, modified limbs: their structure and action are minutely described. The salivary glands open into the buccal cavity by a short common duct, are variable in length, but stretch usually two-thirds the length of the body. They consist of two parts: the first runs backward as a wide, straight tube; the second runs forward and upward, is small in diameter, and apparently branching in the figures, though the fact is not mentioned in the text. The anterior end of the first part serves as a duct, and is lined by a cubical-celled epithelium; while the rest of the same part is

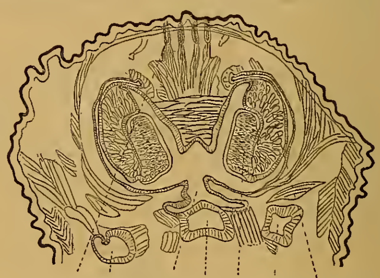


FIG. 1. Horizontal section through the head: *tr p*, tracheal pit; *sal*, salivary gland; *M*, mouth; *s d*, common salivary duct; *J*, jaw; *o j*, outer jaw, or muscular portion; between the two jaws lies the section of the tongue.

glandular, and lined by very elongated epithelial cells with their nuclei at their bases. 2. The pharynx is a highly muscular tube, with a triangular lumen, which extends from the mouth to about half way between the first and second pair of legs. (It appears to me that the author is in error when he states that such a structure is not characteristic of insects.) 3. The oesophagus, on the dorsal wall of which occurs the junction of the two sympathetic nerves. 4. The stomach, by far the largest part of the alimentary tract, has its walls irregularly, not segmentally, folded. The walls themselves are composed principally by the internal epithelium, the cells of which are elongated, fibre-like, with their nuclei about one-fourth of the way from the base; and around their bases are short cells irregularly scattered, and having round nuclei. 5. The short rectum is chiefly remarkable because the circular muscular layer is *outside* the internal layer formed of isolated longitudinal bands.

The *nervous system* is particularly interesting; for it consists of two ventral cords united by numerous transverse bands, and having an enlargement corresponding to each leg. The cords are united in front, above the oesophagus, to form the cephalic ganglia, and are also united behind over the anus. The arrangement of the commissure and nerves of the ventral cords is minutely described. The supra-oesophageal ganglia give origin to the immense antennary nerves, and a few small epidermal nerves; laterally, one-third of the way back, the optic nerves, and two pairs of smaller nerves near the optic; still farther back, a large median nerve from the dorsal surface;

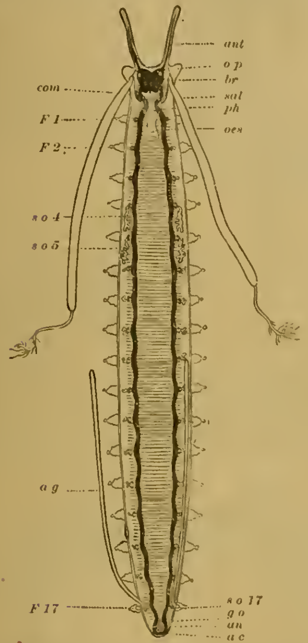


Fig. 2. General anatomy; the digestive tract is supposed to be excised; the nervous system is represented in black: *ant*, antenna; *o p*, oral papilla; *br*, brain; *sal*, salivary gland; *ph*, pharynx; *oes*, oesophagus; *com*, commissures; *F 1*, *F 2*, *F 17*, feet; *s o 4*, *s o 5*, *s o 17*, segmental organs; *a g*, accessory gland; *g o*, genital opening; *an*, anus; *a c*, anal commissure.

from the ventral surface, the sympathetic nerves, which follow the grooves of the pharynx, and unite upon the dorsal wall of the oesophagus. The ganglion-cells are confined, for the most part, to the surface in the supra-oesophageal ganglia, and to the ventral layer in the longitudinal cords. On the under side of each lobe of the brain is a conical protuberance of ganglion-cells, which Grube regards as an organ of hearing; but Balfour questions that interpretation.

The *skin* resembles that of other insects. The cuticle is thin, and forms a separate conical cap over each cell. The surface of the cuticle is dotted over with minute spinous tubercles. Scattered over the skin are organs of special sense, which I think resemble the olfactory organs of insects; but Balfour regards them as tactile. Each is a broad, conical, cuticular spine supported by large specialized sensory cells.

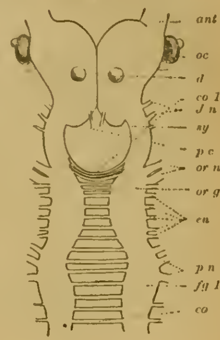


Fig. 3. Anterior portion of nervous system: *ant*, antennal nerve; *oc*, eye; *d*, ventral appendages; *co 1*, first commissure; *J n*, nerves of the jaw; *sy*, sympathetic nerves; *p c*, posterior lobe of brain; *or n*, nerves of the oral papillae; *or g*, ganglion of oral nerves; *en*, lateral nerves of ventral chords; *p n*, pedal nerves; *fg 1*, enlargement corresponding to pedal nerves; *co*, commissure.

The *tracheae* arise from openings between the ridges of the skin. Each aperture leads into a pit formed by the invaginated skin; and from the bottom thereof springs a bunch of fine tracheal tubes, which display large adherent nuclei on their walls, and transverse lines indicating the presence of a spiral fibre. The openings form two rows (subdorsal) on the back, and two rows on either side of the median ventral line; they are also found on the feet, around the bases of the feet, and on the head.

The *muscles* of the jaws are alone striated: all others are unstriated. The muscles of the body form an external double layer of circular fibres, an inner layer of longitudinal muscles forming five bands (one

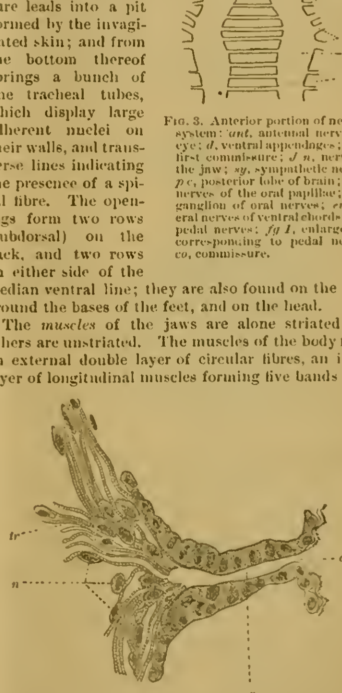


Fig. 4. Section of tracheal orifice: *o*, external orifice; *p*, pit; *tr*, tracheae; *n*, tracheal nuclei.

being median and ventral), and vertical septa of transverse fibres (one septum on each side of the alimentary canal): so that the body-cavity is divided into three regions, — a median, containing the alimentary tract, slime-glands, etc.; and two lateral, containing the nervous system, salivary glands, segmental organs, etc.

The *vascular system* is imperfectly known. Balfour describes a dorsal tube without apparent muscular walls as the probable representative of the heart, and mentions a less distinct ventral vessel. (Cf. note.)

The *segmental organs*, which were first recognized by Balfour,[1] conform to the structures designated by the same name in annelids. They consist of: 1°. a vesicular portion opening to the exterior; 2°. a coiled portion, which is again subdivided into several sections; 3°. a terminal section ending by a somewhat enlarged opening into the lateral compartment of the body-cavity. The first two pairs, corresponding to the fourth and fifth legs, differ somewhat from the rest, which are all similarly constructed. They are lined by an epithelium, which varies in character in the different parts of the organs: in the first portion, the cells are large, flattened, and have large protuberant nuclei; the second portion has a columnar epithelium in its outer part, in which, further, two regions may

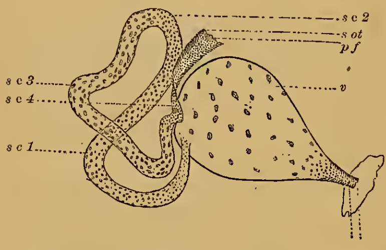


FIG. 5. Part of segmental organ: *o s*, external opening of the segmental organ; *d*, terminal portion of duct; *v*, vesicle; *s c*, *1*, *2*, *3*, *4*, successive portions of segmental canal: *p f*, internal opening; *s ot*, terminal portion.

be distinguished histologically; a third region within this outer part has large, flat, granular cells, with disk-like nucleolated nuclei; while a fourth region, the innermost of the middle portion again, has a lining of small columnar cells. The inner portion has a thick columnar epithelium crowded with oval nuclei, and opens with reflected lips into the body-cavity.

The *generative organs* are briefly described by the editors, who do not, however, deal with their histology. The male organs consist of a pair of testes, a pair of prostates, and vasa deferentia and accessory glandular tubules. The female organs consist of a median unpaired ovary and a pair of oviducts, which are dilated for a great part of their course to perform a uterine function, and which open behind into a common vestibule communicating directly with the exterior. In all the legs except the first there are glandular bodies. The large accessory gland opening in the last leg of the male is probably a modification of one of the series for which the name 'crural glands' is proposed.

Part III., also entirely written by the editors, treats of the development. This contains illustrations, serving to accompany the notice published in the Royal society's proceedings (SCIENCE, i. 453); certain requisite explanations are added; then follow descriptions and figures of older embryos than had been previously described by Balfour. Special attention is called to the following more important facts: —

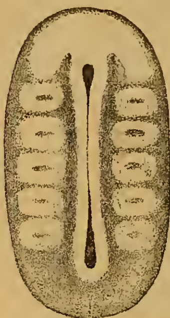


FIG. 6. Embryo, 'stage C,' with five somites: *a*, anal (?) end. The lips of the blastopore have united in the middle.

"1. The greater part of the mesoblast is developed from the walls of the archenteron.

"2. The embryonic mouth and anus are derived from the respective ends of the original blastopore, the middle part of the blastopore closing up.

"3. The embryonic mouth almost certainly becomes the adult mouth; i.e., the aperture leading from the buccal cavity into the pharynx, the two being in the same position. The embryonic anus is in front of the position of the adult anus, but in all probability shifts back, and persists as the adult anus.

"4. The anterior pair of mesoblastic somites give rise to the swellings of the pre-oral lobes and to the mesoblast of the head.[1]

"There is no need for us to enlarge upon the importance of these facts. Their close bearing upon some

FIG. 7. Section through the open blastopore of the embryo drawn in fig. 6: *bl*, blastopore; *mes*, mesoderm; *ec*, ectoderm; *ent*, entoderm.

of the most important problems of morphology will be apparent to all."

The paper terminates with a few appropriate and telling quotations from Balfour's 'Comparative embryology.' The memoir displays the best qualities

[1] Balfour: *Quart. journ. microsc. sc.*, xix. 1879.

[1] "We have seen nothing in any of our sections which we can identify as of so-called mesenchymatous origin."

of Balfour's work, and can only enhance the respect which all biologists feel for him.

[NOTE. — Since writing this notice, I have learned of the paper since published by Gaffron upon Peripatus (*Schneider's Zoologische beiträge*, I. 33). The original I have not seen, but only a notice in the *Biologisches centralblatt*, iii. 319. From the latter it appears that Gaffron has independently observed many of the facts discovered by Balfour, and in some respects has added to them. The following is the abstract of his description of the heart. "As in the tracheate arthropods, it lies in a special pericardial sinus, completely embedded in a cellular mass, most developed laterally. Its walls are perforated by fissures, corresponding to the body-segments, and which must be sought in the upper half of the tube. Along the dorsal median line runs a round cord, which is held (probably wrongly) to be a nerve. The pericardial sinus and the body-cavity communicate through numerous oval openings in the septum."]

CHARLES SEDGWICK MINOT.

LETTERS TO THE EDITOR.

Prairie warbler in New Hampshire.

Several seasons ago the prairie warbler (Dendroeca discolor Bd.), was found nesting at Northfield in New Hampshire, in June I believe, though I cannot give the exact date. Two of the nests, however, and an egg, are preserved, and place the identity beyond question.

The locality was a high, bush-grown pasture in the vicinity of a town; and the nests were pitched about head-high from the ground, in the crotch of a thorn-bush. The birds made no demonstrations at the approach to their haunts, but retired noiselessly, seeking to screen themselves from view. One nest contained three eggs, a second four. They are substantially the same, finely and firmly wrought, cup-shaped structures, with a well-turned rim. In the latter instance, the external depth is 2½ inches, the internal 1¼; outer diameter 2¾, inner 1½. The nest is composed essentially of bark strippings, Andromeda chiefly, fine grass, and blasted vegetable fibre intermingled, and lined with hairs and the reddish filaments of Polytrichum. The exterior is covered with much cobweb silk and some soft compositaceous substance, which serves to compact the whole and secure it in position.

The egg is pointed at one end, dull white, rather finely and sparsely specked with lilac and marble markings, aggregating in a circle about the crown, measures .68 × .50 inches, resembling occasional specimens of the chestnut-sided warbler.

So far as I am aware, there is no previous authentic record of this warbler breeding north of Massachusetts in New England. F. H. HERRICK.

Kalmia.

In your issue for Aug. 17, Dr. Abbott doubts if Kalmia grows sufficiently large to be used for making spoons. The abundant thickets of Kalmia latifolia, beautiful but troublesome, are among the clearest recollections of my youth in southern New Hampshire. This shrub is there familiarly known as 'spoonhunt;' and its stems, near the ground, are not infrequently three or four inches in diameter.

CHAS. H. CHANDLER.

Ripon, Wis., Aug. 23, 1883.

Letters in a surface film.

Can any one suggest an explanation of the phenomenon described below?

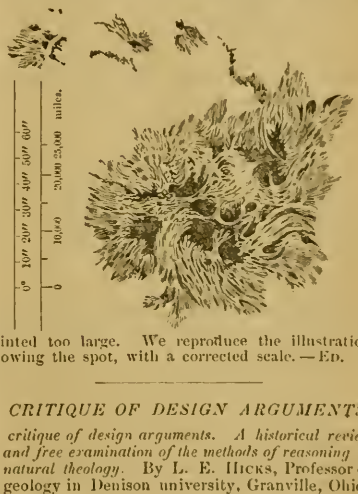
In a box four feet square, and sunk five feet below the surface of the ground, was a water-meter connected with pipes for supplying a factory. Over the face or dial of this meter was a cast-iron cover, on the outside of which the maker's name was inscribed in raised letters. During the spring thaws, the box was half full of surface-water, submerging the top of the meter some eight or ten inches. After a time a greasy film collected on the water, and in this film appeared a counterpart of the raised letters. That it was not a reflection or other optical illusion, was proved by carefully introducing a shovel under these filmy letters, when they were raised and taken outside of the box, being still visible.

In the course of a few hours, fresh letters would appear on the surface. A. P. H.

Boston, Aug. 28, 1883.

An interesting sun-spot.

Owing to a misunderstanding, the scale given with the sketch of a sun-spot, in the letter from S. P. Langley and F. W. Very (SCIENCE, ii. 266), was



printed too large. We reproduce the illustration showing the spot, with a corrected scale. — ED.

A CRITIQUE OF DESIGN ARGUMENTS.

A critique of design arguments. A historical review and free examination of the methods of reasoning in natural theology. By L. E. HICKS, Professor of geology in Denison university, Granville, Ohio. New York, *Charles Scribner's Sons*, 1883. 11 + 417 p. 8°.

THAT men can talk about the most serious problems without passion, is certainly shown by our author, whose candor and excellent aims have already been recognized on all hands. For the rest, we must regard the book with mixed feelings. When we undertook to read it, we did not go forth to see a reed shaken by the wind, nor did we find such; we did not venture to look for a prophet, nor did we find one: but we were prepared for just a little more definiteness of philosophic thought, for just a little more acquaintance with the history of the subject, and, in general, for just a little more strength. But we must not be too exacting. This is the work of a student of a special science. He comes with suggestions that have been a good while in maturing; he expresses himself in clear language, with great and generally successful effort at fairness; and he shows no small ingenuity. His book will do good both to theological and to scientific students if they read it. And it can do no harm to philosophy. Such discussion is, in fact, so timely that one cannot wish that the book had been kept any longer out of print; but one must wish that the author had begun to study the history of thought a good deal earlier. Achilles at the trench will always be a sublime figure; but the lack of armor is not just that feature in the situation of Achilles which it is safest for other people, at other trenches, to imitate.

The argument from design, says the author, is in fact twofold. In one form it is teleological. Certain events or things are judged to be intended for certain purposes. This argument has less signifiance for the men of to-day than it had for former generations. The advance of science throws it somewhat into the shade. But the advance of science itself tends to bring into clearer light the other design argument. This is the argument from the *order of nature*. Order, it maintains, implies intelligence, is itself a mark or sign of mind. The more order we discover, the more intelligence is indicated in the world. This does not necessarily mean that we infer intelligence as the *cause* of order; but it means that we regard order, however it may actually be connected with intelligence, as a *mark* of intelligence. This argument needs a name; and Mr. Hicks proposes to call it the eutaxiological argument, to distinguish it from the teleological.

The teleological argument alone is not satisfactory. To prove that any thing implies intelligence as the cause whereby it was adjusted to an end, you must know what the end or purpose of this thing is. And to do this, you must know that there are ends or purposes for things at all; but to assume that you know this is to beg the question. Teleologically, therefore, intelligence as the cause of things cannot be proven; but only particular adjustments, made by an intelligence already known to be the cause of things, can be teleologically discovered. Teleologically you could at best show, that, if there is intelligence in connection with the world as a whole, then this intelligence works for certain special aims. But teleologically it would be impossible, without aid from some other source, to make certain that any mind at all is associated with the world as a whole. It is impossible 'to prove the *existence* of intelligence by means of the definite *direction* given to intelligence,' because the existence of intelligence 'must be *assumed* in order to ascertain its direction.'

On the other hand, maintains our author, the eutaxiological argument escapes the analogous objection. Teleology has to assume the existence of purpose, in order to use it as a proof of intelligence. But eutaxiology has not to assume the existence of order. Order is the first and last word of natural science; and from first to last science continues to deepen the meaning, and to widen the application, of the word 'order.' The difficulty of the eutaxiologist begins not at this point, but later. Are we sure that order is a sign of intelligence? An orderly arrangement of things is a mark of intelligence in many cases. "Suppose we find smooth stones or shells on the beach, arranged at regular intervals in a straight line, or in three straight lines to form a triangle: we should say that an intelligent being had done this." To be sure, in this case we should suppose that some man had done it; but that would not affect the matter, for, "if we saw such figures upon the moon or upon any of the planets, we should at once conclude that they were inhabited by intelligent beings." Thus in these cases, reasons Mr. Hicks, order is inductively connected by us with intelligence. "We see intelligence producing orderly results; and we project the inference thence derived over those cases of orderly phenomena of which we do not know the cause." But what is done in special cases of order observed in forms or in groupings of objects, ought fairly to be done in regard to the whole of nature; and that especially because every case of orderly connection that we find, and that suggests intelligence, is found not alone, but itself in connection with other cases, so that we could not finally stop with our examination of one case of order before we should know its connections with the whole of the rest of the universe. The more, then, we know of nature, the more orderly and connected does it seem, and the more reason we have to apply our induction to the world as a whole.

All this, of course, implies no definite view about the way in which intelligence is connected with the order of the universe. Whether it be that arbitrary collocations of matter are the immediate sources of the order, or whether the order follows from the fundamental properties of matter, the result is the same. And for a like reason eutaxiology has nothing to say of divine attributes over and above intelligence. Eutaxiology does not even by itself prove the existence of God. It simply proves that intelligence exists in the universe. It leaves to other proofs the discussion of other divine attributes. Eutaxiology having proved intelligence, teleology can then be used to prove that this intelligence is somehow associated with will and power, and works (through evolution or otherwise) for definite aims; and other proofs may be used for other purposes. In conclusion, why may not the various theistic arguments agree to divide labor, and combine the outcome, so that each one shall undertake to prove just that divine attribute to whose defence it is especially fitted? Thus confusion might be avoided, and the cause of natural theology advanced. Mr. Hicks even goes so far as to suggest, in a very generous outburst (p. 389), that possibly that despised creature, the ontological proof, might find some kind of mission in the midst of his desired association of theistic arguments. The ontological proof, having very long been able to say, —

> "I lie so composedly now in my bed,
> That any beholder might fancy me dead,"—

must regard the kindness of Mr. Hicks with very mixed emotions. He thinks that it might be 'just the thing to supplement' the others. But during its natural life the ontological proof used to think that the others might possibly be of use to supplement itself.

Such, then, is our author's own line of argument. Between the introduction and the final exposition of this argument, he inserts a discussion of the history of design arguments. This is a mere collection of notes, with more or less ingenious reflections that suggested themselves to the mind of the collector here and there in the course of his work. The 'Natural theology of the Greeks and Romans' is treated in some thirty pages, which are devoted to Socrates, Cicero, and Galen. How, one may ask, would it look for one to head a chapter with the title 'The astronomy of modern times,' and then to treat the subject by briefly expounding some statements of Galileo, Lord Brougham, and Dr. Whewell? Thirty pages might well be the limit allowed by the plan of our author; but such a space is not too limited for a really connected historical sketch, with some attention to the perspective in which every man's thought ought to be viewed. The author's account of Spinoza is similarly imperfect, because no effort has been made to see what the man, with his odd, crabbed method, really had in mind. We are told, what we all knew before, that Spinoza's method is unsuccessful; but, for the rest, we learn more in this chapter about Mr. Lewes than about Spinoza. 'Reimarus, Kant, Hume, and Reid' are somewhat embarrassed to find themselves side by side in one chapter; and poor Kant especially is made to speak as he did in 1763, instead of being allowed to present himself as he does in the 'Critique of pure reason,' nearly twenty years later. Although this error is in just this discussion not so serious as the corresponding error would be in expounding other parts of Kant's doctrine, yet the method is unhistorical; and the result is, that, in summing up, Mr. Hicks hopelessly confuses Kant's pre-critical and critical periods. In short, our author shows himself in general no historian of thought. Throughout the whole sketch, there is a lack of a sense of the development of thought. Each man's notions stand beside his neighbor's, as if the philosophers were all speakers in a debating-club. And Mr. Hicks, as intelligent listener, adds his applause and his comments in brackets, and is not afraid to express himself with even boyish freedom of speech. But he is always good-humored, and his criticisms often hit the mark very well. Yet it is to be hoped that nobody will undertake to judge the history of natural theology on the basis of this account.

Now as to the result. What shall we say of eutaxiology? We have no hesitation in declaring the argument, as our author presents it, an altogether defective one. For, as he presents the eutaxiological argument, it is an inductive argument, and solely inductive. If we saw a triangular arrangement of objects on the moon, we should conclude that some intelligence had done this. We should extend the known association of intelligence and order, as we find it about us, to cases of order more remote from our direct observation. We should conclude that order is a sign of intelligence, even where we have no other evidence of the presence of intelligence. So reasons Mr. Hicks. But is this sound? And, first, is the author's suggestion about the supposed geometrical figure seen on some planet a correct one? Should we, if we saw such a figure on some planet, at once conclude that intelligence had caused it, or was in any way associated with it? Surely not everybody would feel the force of such an induction.

Most scientific astronomers, observing such a regular figure for the first time, would at once look for some ordinary physical explanation of its presence, even as they now try to explain the shapes of the planets; and, failing to find such an explanation, they would be content to call the triangle a mystery. Only some man whose position as a public lecturer on astronomy demanded that he should have a new sensation ready for each new lecture-season would be apt to insist on the existence of some set of geometrically disposed planetary giants. More sober people would be content with an *ignoramus*. But how much less satisfactory becomes such an induction when applied to the whole of nature! At best would not such an argument be like the inductive reasoning of a man, who, having already learned the modern doctrine of the relation of the colors of flowers to the habits of insects, should for the first time, and without any previous knowledge of marine zoölogy, find a colored shell by the sea-shore, and who should then at once expect to find some race of insects in some analogous relation to the inhabitant of this shell? Or, again, if one extended even to the rainbow, or to the sunset, an explanation derived from the case of colored flowers, and their relations to insects, would not the argument possibly be no more absurd than the induction upon which Mr. Hicks lays so much stress? Men and beavers and other creatures make orderly groupings of things. Hence order implies intelligence, and that wherever we find order. Is this argument any better than the old teleology?. Mr. Hicks is deceived, it would seem, by the vast wealth of facts to which his argument appeals. He neglects the difficulty of bringing such various facts within the control of an induction that has for its narrow basis such intelligent activity as we see about us among men and animals. As induction, pure and simple, eutaxiology seems to us simply worthless.

But is the order argument in any form therefore worthless? Certainly not. Mr. Hicks does fine service in bringing before the public, just at this moment, a thought that is by no means new, and that is profoundly suggestive. 'What does the order in the world imply?' This is a great question, not of inductive science, which is concerned solely with discovering the actual order itself, but of general philosophy. And Mr. Hicks is, we doubt not at all, quite right in saying that order implies intelligence. But how, and what intelligence? Such questions he leaves wholly unanswered. The critical philosophy of Kant would, strictly speaking, affirm that order in the world implies only the intelligence of the thinking subject to whom the world appears. The world is orderly, because only as orderly could it become known to an intelligent being. Not the world in itself, but the world for thinking beings, is to be viewed as orderly. This view would make short work of our author's 'induction,' but it would not satisfy him. He would then need to know and build beyond Kant. In short, Mr. Hicks has very ingeniously set his reader down at the beginning of a great philosophic problem. It would argue a lack of intelligence in the reader if he did not seek to bring his thoughts into a better order than that in which Mr. Hicks will have left them; and the author's service lies in making it impossible for an inquiring mind to rest content with what is here offered to him. This, however, at least, he has very well suggested, though he has not proved his suggestion: viz., that the postulate of natural science is the rationality of the world. Whether we find order, or only seek it in nature, we are always *a priori* sure that the world is actually full of connections that admit of expression in rational terms, of explanation to an intelligent mind. And so we assume a fundamental likeness of nature and intelligence that suggests to us very strongly some kind of real unity or identity of nature and intelligence. But whether this suggestion has any ground, whether this identity of nature and mind is to be accepted at all, or is to be accepted in Kant's sense only, or in Berkeley's sense, or in Hegel's sense, or in some other sense, this is a matter for philosophy to discuss. We thank Mr. Hicks for having shown afresh the necessity for such discussion. His eutaxiology is not so original as he thinks; but his offering on the altar of philosophy deserves the reward due to every gift that a special student of natural science finds time to offer in the true spirit of calm investigation.

MAYNARD'S MANUAL OF TAXIDERMY.

Manual of taxidermy: a complete guide in collecting and preserving birds and mammals. By C. J. MAYNARD. Boston, *S. E. Cassino & Co.*, 1883. 16 + 111 p., illustr. 12°.

A REALLY *complete* guide in collecting and preserving the objects named in the title of this work, which can safely be relied upon for information under all circumstances and in all climates, has long been sorely needed by the host of amateurs, taxidermists, travellers, and even professional naturalists interested in vertebrate zoölogy. Notwithstanding the presence of the neat little volume before us, and its promising title, a complete guide is still as much a desideratum as ever. Like all other books which have appeared in English on this subject, this volume is small and thin, and, we are compelled to add, wretchedly illustrated. Of the one hundred and one pages of subject-matter, sixteen are frittered away in an effort to inform the reader where birds of the various families from Turdidae to Alcidae are to be found. How much better to have devoted this space to adequate instructions for mounting dried skins, which important branch of the subject is summarily disposed of on a single page, instead of to such cheap information as that 'the chimney-swift inhabits chimneys,' that kingfishers are found 'in the vicinity of streams,' and the like. With the exception of the above, all the information and advice contained in the chapter on collecting is valuable, and bears the stamp which experience places upon its work.

The chapters on 'skinning birds' and 'making skins' would be very satisfactory but for one thing. While the author strongly condemns dry arsenic as a dangerous poison, and says not a word about arsenical soap, the only preservative he recommends as fit for use is one compounded only by himself. After extolling its virtues to the extent of two pages, but carefully withholding all information as to its composition, he coolly informs the reader that its price is 'twenty-five cents per single pound.' We are told that tannic acid, alum, salt, or black pepper (!) may be used to temporarily preserve skins until the other can be procured. The 'dermal preservative,' which, strange to say, is not a poison, is recommended, or rather exclusively directed, in no fewer than fourteen places throughout the work, for mammals, birds, reptiles, and fishes, as a non-poisonous astringent, absorbent, deodorizer, and insecticide; and, if the reader is at all credulous, he will be led to exclaim, There is but one preservative, and C. J. Maynard is its maker! If this little book is honestly intended to meet the wants of amateur collectors wherever it may find them, and not to increase the sale of a nostrum of doubtful value, nor to advertise the author's business, the author has taken a queer way to show it. It will not be surprising if his readers resent such unfair treatment.

While there is much that is practical, valuable, and new in the chapter on mounting birds, and in those detailing the treatment of mammals, reptiles, and fishes, they are all deplorably incomplete; and we vainly regret that the author did not go as deeply into the subject, and with as good diagrams and illustrations, as he might have done. The information given is valuable as far as it goes; but there are only one-quarter as many facts stated, and directions given, as the unskilled operator needs to know.

As an example of the doubtful value of such highly condensed instructions, we may take those for skinning small mammals. The author says, ". . . peel down on either side [of the body] until the knee-bones are exposed, then cut the joint, and draw out the leg, *at least as far as the heel.*" Not a word is said about skinning the foot, and removing the flesh under the metacarpal and metatarsal bones: hence we suppose it is left to decompose, which it will generally do right speedily, and at the expense of the hair and epidermis above. We should like to see the author remove and prepare the skin of any monkey according to his own directions.

We are honestly sorry we cannot freely recommend this manual — nor any other in our language, for that matter — as being well calculated to meet the wants of those for whom it is intended. An epitome of the subject is no longer wanted, but a handbook which shall be really complete is needed very much.

ELEMENTARY TREATISE ON THE MICROSCOPE.

Traité élémentaire du microscope. Par Eugène Trutat, Conservateur du musée d'histoire naturelle de Toulouse. Paris, *Gauthier-Villars*, 1883. 322 p., 165 ill.

Few are aware of the magnitude to which microscopical work has grown. The modern methods of research in the physical and biological sciences have involved more and more an appeal to the microscope. As a result of this growth, we find whole volumes devoted to a description of the microscope and its application to the various departments of study.

Microscopy has been taught in our schools only a very few years. This is partly due to the fact that formerly the instruments were both expensive and imperfect. There was also an almost total lack of literature upon the subject. At the present time, however, there are plenty of good works on microscopical technology, and the microscope as applied to the study of medicine in all its branches, including biological research.

In a work like this before us, it is necessary to present a large amount of material of such an elementary character that it is of value only to the novice. It is decidedly a French work, written by a true Frenchman. Neither an instrument nor an accessory is mentioned, unless either invented or manufactured by a Frenchman. The stands of Verick are given great prominence, as are also those of Hartnack. When we consider how beautiful and useful are the instruments of our own country, to say nothing of the fine productions of English houses, we are forced to call the work 'an elementary treatise on the French microscope.' For convenience, elegance of design, and varied adaptability, the French microscope will not compare with those of our own country, while we far excel in the superior quality of our objectives.

The microscopist will be much interested in reading the chapter on the projection microscope. Electricity will soon furnish us with proper illumination.

More information is given under the head of mineralogical research than in any work brought to our notice. Among the accessories mentioned is the camera lucida of Oberhauser. It is a form little used in America, and yet it is one of the most convenient and perfect of its kind.

The new pattern of Malassez's *Compte-globules*, by Verick, is minutely described. The results obtained by this instrument promise to be very accurate: we have practically tested its merits, and can give testimony to its precision. The method for photographing from the microscope is not so simple as that employed here by the use of dry plates; and, if the frontispiece be taken as a sample, it is not more satisfactory. The author shows perfect familiarity with the instruments and accessories, together with their applications as made and used in his own country. C. H. STOWELL.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

PROCEEDINGS OF SECTION E.—GEOLOGY AND GEOGRAPHY.

Reports of committees on geological subjects.

To the call for a report of the *Committee to memorialize the legislature of New York for a new survey of Niagara Falls*, Prof. James Hall responded, that several surveys had been made, or were in progress, in connection with legislation by the State of New York for preserving the scenery. These would supersede the need of any work of the kind by the association. The committee was discharged.

To the call for a report of the *Committee on state geological surveys*, Prof. N. H. Winchell responded, that the committee had never been called together, and there was no probability of its action. The committee was discharged.

To the call for a report of the *Committee on the international congress of geologists*, Dr. T. Sterry Hunt (by request of the chairman, Professor Hall) responded as follows:—

The committee held a meeting in the month of November last. Two important questions came up,—of geological nomenclature, and topography. It was suggested by Professor Hall, that the only action which could be taken in support of the system of uniform mapping and colors, and signs and symbols, would be to prepare maps of the United States as a whole, and perhaps also maps of portions of the United States, and to color them by different systems; the system adopted being that of Major Powell of the U. S. geological survey, and one or two others. Major Powell has been good enough to say that he would endeavor to prepare such maps, and aid in every way the carrying-out of the scheme. I have no doubt that the matter will be so well managed that the whole question of geological topography will be settled.

As to the question of geological nomenclature, we had much difficulty in getting reports of the previous meetings; and we have named several persons, some of whom have already handed in, or have in process of preparation, their abstracts of geological nomenclature; and I have every reason to hope that in the course of a few weeks we shall have the whole of that matter in shape to transmit to the Berlin congress a full and proper representation of the views of American geologists with regard to our geological nomenclature. There is one thing very much to be regretted,—the possibility that the meeting of the American association and the British association will come in collision with the meeting of the Berlin congress. Nothing definite has been arranged, so far as I can learn by letters. I have met with no response, but I was told that the time of the Berlin congress had not been fixed. In the committee which was held to consider arrangements for the meeting of the British association, it was suggested that we put ourselves in communication with the local authorities of the Berlin congress, and endeavor to get them to fix the time of their meeting so late in September as will allow members of the American and British associations to leave this continent after the meeting of our associations so as to be present at the Berlin congress.

The committee was continued.

The *Committee to confer with the United-States geologist in regard to co-operation between government and state geological surveys* was called on for a report. Prof. James Hall of Albany responded in-formally: The condition of the state survey is likely to be materially influenced by the law of the general government extending the U. S. geological survey over the states. Proper deference to the head of the U. S. survey required that some action should be taken by which we could confer with Major Powell, to understand our relations to the survey. To prevent any jealousy or uncertainty with regard to what might be the relation of the state survey and the general survey, I suggested the appointment of this committee. I had no intention myself of taking any active part in the matter; and I think there are gentlemen on the committee, much younger than myself, who will do all the work. I believe several members of the committee have had very pleasant interviews with Major Powell, as I have myself, since these meetings commenced; but I had forgotten that I was to make a report. I think it is desirable that there should be very frank intercourse between the gentlemen who are conducting the state surveys and the head of the general government survey, so that we may know what is to be the result of their various surveys which are so very important to geological science. Workers at a distance from each other cannot, without some means of inter-communication, — which, I think, may be established with the head of the general survey, — bring the results of their labors to a fair comparison with those which are done a thousand miles away.

Major Powell expressed the hope that the committee would be continued. Several members of the committee had conferred with him with reference to the surveys, but they had not conferred as a committee. Practical relations have been established between the general survey of the United States and several of the state surveys. He thought it was probable that such arrangements could be established as would make it satisfactory to all.

The committee was continued.

PAPERS READ BEFORE SECTION E.

(*PAPERS ON GLACIAL PHENOMENA.*)

The life history of the Niagara river.

BY JULIUS POHLMAN OF BUFFALO, N.Y.

A series of observations whose points were given in detail had convinced the author that the formation of the gorge of Niagara had been a matter of tens of thousands, rather than of hundreds of thousands, of years. The beginning of the history might be stated as in the pre-glacial epoch. A lake then occupied the valley of the Tonawanda; its outlet was the line of the ancient Niagara River from the falls to the whirlpool; thence, by way of the St. Davids valley, into the Ontario valley. All these valleys were closed during the glacial period. The subsidence of Lakes Erie and Ontario was that of one body or region, until they were separated by the Lewiston escarpment; after that the drainage of Lake Erie found its path through drift deposits and old existing valleys to Lake Ontario. The latter lake subsided slowly, and no waterfall was formed at its entrance. The river excavated its gorge to the whirlpool, not by means of a retreating fall, but as a rapid in an old shallow valley. At the third pool, this path met the ancient river-valley: it was along that valley only, that the falls receded to their present site. The retreat of the fall was not the means of excavation, for at least seven miles usually ascribed to it; the portion which would offer the most resistance, between the falls and the whirlpool, being already excavated.

From that point to Lewiston, the progress was very rapid in cutting the gorge; a shallow valley had partly removed the hard limestone, and the softer underlying shale rock was a barrier much more easily penetrated. We have no exact data of the retrocession of the falls within periods of modern observation. A comparison of Professor Hall's map of the falls in 1841, and that of the United-States lake survey in 1875, shows wide discrepancies. After all reasonable allowance for inaccuracies, we must admit that parts of the Horse-shoe fall have receded in thirty-four years at least one hundred feet, and on the American side the recession is from twenty to forty feet. These facts all tend toward a shortening of the history of the present river.

In the discussion that followed, Professor Hall expressed a doubt as to the dependence that could be placed on differences between surveys made by different persons, using differing methods. That there had been retrocession within the period of our observation, he did not doubt; but it could scarcely be so rapid as was indicated by the estimates of Dr. Pohlman. Other speakers discussed the paper, which was of special interest, because it fired the first gun of the glacialists in the geological section, and it roused their opponents.

Glacial cañons.

BY W. J. McGEE OF SALT LAKE CITY, UTAH.

This paper was read, in the absence of its author, by Mr. Warren Upham. It considered the action of a glacier as being, to a certain extent, capable of representation by mathematical formulae. It was admitted, however, that some of the quantities in the equations must remain very indefinite. The paper was almost wholly theoretical, and arrived at the following conclusions: The temporary occupancy of a typical water-cut cañon by glacier-ice will, 1°. increase its width; 2°. change the V to a U cross profile; 3°. cut off the terminal portions of tributary cañons, and thus relatively elevate their embouchures; 4°. intensify certain irregularities of gradient in the cañon bottom; 5°. excavate rock basins; 6°. develop cirques; and, in general, transform each cañon into an equally typical glacial cañon. It follows that these features do not necessarily imply extensive glacial excavation, or indicate that glaciers are superlatively energetic engines of erosion.

Owing to the custom of abstaining from discussion on a paper in the absence of its author, the dissentient opinion of many who were present was not fully elicited. The general expression was to the effect, that the theory had been framed without sufficient observation of the facts, and that, if the author had taken the trouble to see and examine various cañons, he would have come to a widely different set of conclusions.

The ancient glaciation of North America: its extent, character, and teachings.

BY J. S. NEWBERRY OF NEW YORK.

WHILE the glacial area on our continent has not been fully explored, there is abundant proof for the following propositions: 1°. Glaciers covered most of the elevated portions of the mountain belts in the far west as far south as the 36th parallel, and in the eastern half of the continent to the 40th parallel of latitude. 2°. The ancient glaciers, which occupied the area above described, were not produced by local causes, but were evidences of a general climatic condition. 3°. They could not have been the effect of a warm climate and an abundant precipitation of moisture, but were results of a general depression of temperature.

The traces of glaciation are similar in kind, and apparently in date, over the whole area: they are therefore effects of general, not of local, causes. East of the Mississippi, the evidence is even more widespread and impressive than in the far west. The area bearing marks of ice action, and strewn with drift, extends from New England westward, parallel with the Canadian highlands, in a belt five hundred miles wide and over two thousand miles long. Its northern extension has not been traced beyond Winnipeg; but there are reasons for believing that it reached to the Arctic ocean, and that the great lakes are pre-glacial river-valleys, scooped out and modified by ice. Fully half the continent north of the 36th parallel was glaciated. So far as we now know, the glaciation was synchronous.

The iceberg theory was opposed by Dr. Newberry, on the following grounds: It postulated a water-line with irregularities of level that are irreconcilable. The direction of the scratches, and the lines of deviation of the bowlders, require that the northern portion of the continent should have been all submerged, leaving no land for the origin and starting-point of icebergs. If the icebergs could have been formed and floated, an incomprehensible tangle of ocean-currents would be required to account for their movements. The evidence of sea-covering, in the form of marine shells, is totally absent from the great drift area of the interior, while they are found abundantly in the Champlain and bowlder clays of the coast. Finally, the inscription left by the eroding agency is characteristic and *sui generis.*

The record of the ice period on our continent is far more extensive and impressive than it has been represented. The phenomena were due to an extraneous and cosmical cause, not to any thing local or even telluric. The question here passes from the geologist, and must be addressed to the astronomer. Professor Newberry briefly recapitulated some of the theories which have been suggested by Croll, Newcomb, and others, to account for the glacial epoch.

Result of explorations of the glacial boundary between New Jersey and Illinois.

BY G. F. WRIGHT OF OBERLIN, OHIO.

AFTER citing reasons for desiring a careful *résumé* of the subject, — the observations being scattered in the works of different explorers, — the author proceeded to name those who had determined, for different regions, the southern boundary of the glacial area. Starting at the eastern coast, President Edward Hitchcock was the first to intimate that the backbone of Cape Cod was a part of the terminal moraine if the theory of Professor Agassiz were true. Clarence King made a similar assertion as to accumulations near Wood's Holl and on the Elizabeth islands. Professor Charles H. Hitchcock declared that the backbone of Long Island was the foot of a terminal moraine. Warren Upham went over this field, from the end of Cape Cod to Brooklyn, to verify the hypothesis. Professors Cook and Smock traced the moraine across the state of New Jersey. Professor Lesley commissioned Professor Carvill Lewis and the author of the paper to continue the exploration across Pennsylvania. In Ohio, Professor Newberry has approximately outlined the boundary; but in Ohio, Indiana, and Illinois, the survey was carried on by a number of different persons before the most distinctive glacial features were fully understood.

The chief indications on which reliance can be placed to determine glacial action are striated rocks, striated stones, bowlders, and till. Rocks near the margin are often so deeply embedded in till, that their markings are not apparent. The softer rocks do not always retain their striae: this has often been the case in Ohio. In certain situations, stones might be striated by a landslide, or the grounding of an iceberg; but the area over which striated stones are found is too vast for such explanation of their presence. The bowlders are of granite and metamorphosed rocks from northern Canada and the shores of Lake Superior: their presence is relied upon only when they are on such high lines as to preclude the likelihood of their having been transported by the agency of rivers. Till is spread over the whole area: it is defined as an unstratified deposit, containing striated stones of various sizes, — fragments of rock foreign to the locality. Its composition varies, through mixture with underlying material. It covers and gives fertility to northern Ohio, Indiana, and Illinois. Till has been characterized by Professor Newberry as the grist of the glacier.

Briefly told, the boundary-line of the glaciated area, so far as now accurately known, is as follows: Beginning on the island of Nantucket, it runs through Martha's Vineyard, No Man's Land, Long Island from east to west, across Staten Island, entering New Jersey at North Amboy, and after bending northward and making a right angle near Dover, crosses the Delaware at Belvidere. Thence it runs north-westerly through Northampton, Monroe, Luzerne, Columbia, Lycoming. Tioga, and Potter counties in Pennsylvania, and Cattaraugus county, New York, reaching its most northerly part about five miles north of Salamanca. From here it runs through Warren, Venango, Butler, Lawrence, and Beaver counties, to the Ohio line, crossing Beaver creek at Chaintown about fifteen miles above the Ohio river.

The boundary enters Ohio in the northern part of Columbiana county, and proceeds nearly west to the middle of Stark; then turns more to the south, touching the corner of Tuscarawas, and dividing Holmes into two nearly north-and-south sections. Near the north-east corner of Knox, the line makes a right angle, and runs south through Knox, Licking, the north-west corner of Perry, Fairfield, Ross, Highland, Adams, and Brown counties. Then it follows the line of the Ohio river across Clermont, and enters Kentucky near the boundary between Pendleton and Campbell counties, and, after crossing the northern part of Kenton and Boone counties, recrosses the Ohio, entering Indiana a little below Aurora.

In Indiana the line still continues to bear in a southerly direction through Ohio and Jefferson counties, grazing the edge of Kentucky again opposite Madison, and reaching its southernmost point near Charleston in Clarke county, Ind. From here it bears again to the north, through Scott and Jackson counties, to the line between Bartholomew and Brown, and follows this to the north-east corner of Brown. There again it turns to the south-west, touching the north-east corner of Monroe, where it again bears north for ten miles, to near Martinsville in Morgan county. Here again the line turns west and south, passing diagonally through Owen and Green counties, and in Knox as far as Harrison township, ten miles south-east of Vincennes. Beyond this point, the author did not propose at present to trace the line.

The signs of glaciation cease where there is no barrier to account for their cessation, and where no barrier ever could have existed such as must be supposed if the so-called glacial phenomena are the product of floating ice. Of the correctness of this inference, the different elevations at which the signs of glacial action cease are sufficient proof. For instance, the line is near sea-level in New Jersey; in Pennsylvania it rises over Mount Kittatinny to a height of 1,200 feet, then descends 800 feet into a valley, and, again rising, reaches the summits of mountains 2,000 feet above sea-level. Crossing the valley of the Susquehanna at an elevation of only 500 feet, the line mounts the Alleghanies diagonally, and runs over them at a height of 2,500 feet.

The paper proceeds to describe certain marked features of glaciated areas. South of New England, the terminal line is characterized by a series of glacial hills, 100 to 300 feet high. These are also observable in New Jersey, near Plainfield and Menlo Park.

Among the most interesting results of the author's survey in Ohio, was the demonstration of the existence of an ice-dam across the river at Cincinnati. The line bounding two glacial accumulations crosses the Ohio river into Kentucky, near the boundary between Campbell and Pendleton counties, about twenty-five miles above Cincinnati, and recrosses it near Aurora, Ind., about twenty-five miles below Cincinnati, thus filling the channel for about fifty miles of its course. The Ohio, it should be said, occupies, throughout nearly its whole extent, a narrow valley of erosion, not often more than a mile wide, and from 300 to 500 feet deep. Emptying into the main channel there are subordinate channels all along, of smaller dimensions, but of nearly equal depth. The proofs that the ice bodily crossed the river at the point indicated are, that till and granitic bowlders are found in the Kentucky hills south of the river to a certain distance, and not beyond it.

To the question, Why is the boundary of the glacial area so crooked? the author replied at some length; assigning as a principal cause, aside from differences of level, the probability that unequal amounts of snow fell over different regions of the north. The effect of such differences of accumulating snowfall, in determining the extension of the glacial outline, is illustrated by supposing that two loads of sand are placed in one pile, and one load in an adjoining pile; when the sand will flow downward to unequal distances upon a level.

A little reflection will show that the glacial theory will not make extravagant suppositions as to the amount of ice required. The ice was indeed 600 feet deep over New England, and, very likely, of an equal depth over the area to the west; but it is not necessary to suppose a great increase of this depth to the north. All that is necessary is to suppose great accumulations of ice to the north of the granitic hills of Canada, starting a movement past them to the south. This movement may have been kept up toward the margin by fresh accumulations of snow upon the spreading glacier. An accumulation of snow over the glacier in any part of it would spend its effective force in giving impetus to the movement of the front along the lines of least resistance.

The discussion which followed the reading of this paper took a wide range, as the paper itself contained many points of interest. The opponents of the glacial theory, or of the younger theories which have sprung from its loins, based their criticisms chiefly upon doubts of the evidences of glaciation. The questions raised, as to the distinctive characteristics of glacial and subaqueous deposits, gave tone to the paper of the next speaker, which was delivered orally, and was, at least in part, extemporaneous.

The terminal moraine weat of Ohio.

BY T. C. CHAMBERLIN OF BELOIT, WIS.

This paper was introduced by a statement of the author's views on some points that had been alluded to in the discussion of Professor Wright's paper. Dr. Chamberlin had himself observed the features of the drift-bearing area west of the Rocky Mountains. Certain of the drift clays are unquestionably glacial: others have quite as certainly had a wholly different origin. He specified with great particularity the means for discrimination between the clays, but admitted that there were instances where the different types seem to blend insensibly into each other.

West of the Scioto valley, the border of the drift-bearing area is not marked by what is regarded as a moraine. There is, however, an extension of what Professor Wright has characterized as the 'glacial fringe,' consisting of bowlders. In Dakota county, Minn., this fringe is very wide. At Crystal lake there is a well-marked moraine, and possibly there is another a little to the westward. Farther to the west, there is no accumulated morainic drift. West of the Missouri, there is no evidence of glacial ploughing.

A line of drift-hills known as the Potash Kettle range, in eastern Wisconsin, had been regarded as an old beach-line. Dr. Chamberlin has ascertained that the range is a glacial moraine. He described it as an interlobate moraine, formed jointly by glacial lobes occupying the valleys of Lake Michigan and Green Bay, respectively. This was correlated with moraines to the westward in Wisconsin.

Furthermore, there was a system of moraines, — a belt or group, including the glacier lobes at Lake Michigan, in the Chippewa valley, at the western extension of Lake Superior, and in the valley of the Minnesota River, and Red River of the North. These moraines were more pronounced, with a few exceptions, than those on the outer edge. Investigations were being carried eastward with a view of showing their correlation with other moraines in that direction. The hypothesis of their exact correlation, of course, would imply that they were contemporaneous; but there are doubts upon that point.

The author claimed, that there were evidences that the lake-basins were caused in part by depressions during the ice age, caused by the exceptional accumulation of ice in the basins. He deprecated the notion that subsidence must always take as long a period as elevation, or that the reverse is true. He applied this to the case which he alleged of the depression during the presence of ice in the lake-basins, and the elevation since.

In discussing this paper, Professor Lesley said it was time to cry halt as to this theory of depression by weight of ice. It was made to do duty for a great variety of emergencies. In point of fact, ice was much lighter, very much lighter, than any rock. Professor Lesley pointed out instances where this theory had been advanced to account for depressions which now contained a greater weight than the ice could have made with any reasonable hypothesis of its thickness.

Professor Chamberlin explained the theory further, and claimed that in instances which he cited the depression was greatest at the weakest part of the strata.

Prof. E. S. Morse referred to some English experiments to determine the question whether the moon's attraction deformed the earth's outline. It was found (according to newspaper report), that the weight of the incoming tide deformed the surface to such an extent that the effect of the moon's attraction could not be separately calculated. Major Powell called attention to the theory, that, if the earth were divided into conical sections radiating from its centre, there would be found an equal pressure in each. Every sediment, every erosion of the surface, must be balanced by corresponding depression or rise elsewhere. Finally, the case of Lake Saltonstall was cited by Mr. Hovey. It is evidently situated in a valley that was ploughed out by the foot of a glacier; certainly not in a hollow caused by pressure. Professor Cox clung to another theory entirely, as to the great lakes. He believed them to be prolongations of a sea-coast which had at one time extended to them through the valley of the St. Lawrence.

The Minnesota valley in the ice age.

BY WARREN UPHAM OF MINNEAPOLIS, MINN.

The paper was based upon the author's observations for three years as assistant on the geological and natural-history survey of Minnesota, under the direction of Professor Winchell. To the question: During what ages was the glacial, rock-walled channel of the valley of the Minnesota River formed? — the paper offered an answer. Deposits of cretaceous clay were found in water-worn hollows at several enumerated localities; and, in other places, cretaceous sandstone and shale occasionally containing lignite. It thus appears, that, before the cretaceous age, a deep channel had been cut by some river in the lower magnesian sandstone, and the Potsdam formation. The slopes, the drainage, perhaps even the channel, of that river, were not widely different from those of the present; but that channel was probably eroded during the later paleozoic and earlier mesozoic ages, before the cretaceous subsidence.

In the first epoch of glaciation, when the ice covered its greatest area, a thick drift-sheet, mostly unmodified, probably covered all this region, including the preglacial valley, with an unbroken, though undulating, expanse of till. During the ensuing interglacial epoch, the drainage cut a channel, whose position was largely determined by the slopes of the erosion which had preceded the glacial epoch. The preglacial, and also the interglacial river, lay far below the present stream. The till of the later epoch blocked the course of the river only in part of its extent, and the obstacle was soon channelled anew.

During the recession of the last ice-sheet, the valley was filled with modified drift. After the ice was melted in the Minnesota basin, this avenue of drainage was, for a long period, the outlet of Lake Agassiz. The volume of water that it carried was very large, being supplied by the melting ice-fields of Northwestern Minnesota, and from the region of Lake Winnipeg and the Saskatchewan. While streams poured into this river from the melting ice-sheet, its modified drift continually increased in depth; but, when the great glacier had sufficiently retreated, the water from Lake Agassiz not only ceased to contain drift, but became a powerful eroding agent. The deposited drift was mostly swept away, and the channel was again excavated, perhaps to a greater depth than the present river, possibly to the bottom of the gravel and sand, at a point in the valley which is 150 feet below the river there, and 135 feet below low water in the Mississippi at St. Paul.

When the ice-barrier which had made Lake Agassiz disappeared, that lake was drained northward toward Hudson bay. Thenceforward, the rivers of the Minnesota and Mississippi valleys carried only a fraction of the former volume of water from this source. They have since become extensively filled with alluvial gravel, sand, clay, and silt, brought in by the tributaries of those rivers. The changes produced by this post-glacial sedimentation have been ably discussed by Gen. G. K. Warren, and were briefly summarized in the paper of Mr. Upham.

Lake Superior seems to have been held by an ice-barrier at a level of about 500 feet from its present height. The locality of its overflow was stated, and various results detailed. Lake Michigan, until the ice-sheet receded from its northern border, discharged southward by the Illinois river, which, like the former outlet of Lake Superior, was eventually obstructed by alluvium, so that now it has a very slight current for two hundred miles.

The paper closed with a proposition to call the ancient river of the glacial age, the river Warren, in honor of Gen. G. K. Warren.

The discussion which followed was, in part, a conflict between the glacialists and their opponents, and, in part, a debate upon the general question of naming geological features after distinguished investigators.

Changes in the currents of the ice of the last glacial epoch in eastern Minnesota.

BY WARREN UPHAM OF MINNEAPOLIS, MINN.

Without a map, or a thorough familiarity with the region referred to, this paper would not convey very definite ideas. Through some inadvertency the map intended to be used was not on hand when the paper was read. The author's observations had led him to conclusions of a very definite character. He conceived, that, when the ice of the last glacial epoch attained its maximum extent, there were two ice-currents. One moved south-westerly from Lake Superior, across the north-east part of Minnesota, spreading a reddish till with bowlders and pebbles, and limited by a line from Lake St. Croix south-west across the Mississippi, and thence bending north-west by Lake Minnetonka, and through Wright and Stearns counties. The other portion of the ice-sheet was pushed from the region of Lake Winnipeg, south and south-east. The two met along a line from Stearns county, south-east by Lake Minnetonka to Crystal Lake, Dakota county. Afterward, when the ice had partly melted and retreated, a second and inner terminal moraine was formed. Owing to climatic changes (the rationale of which was carefully and very explicitly set forth in the paper), the current from the north-west pushed back that from the east, and covered the reddish till, already deposited, with a blue till from the west and north-west, also abundant in its peculiar bowlders and other evidences of its source.

The kame rivers of Maine.

BY G. H. STONE OF COLORADO SPRINGS, COL.

In the absence of its author, this paper was read by Mr. Upham. After defining and describing the characteristics of kames, and stating that they are very numerous in Maine, where he had observed them, the author proceeded to discuss a single question in relation to these geological features. Most glacialists are agreed that the kame gravels of the drift region were chiefly deposited by glacial streams. The question is, whether these streams were sub-glacial or super-glacial. In exploration during the past five years, the author had found evidences of both kinds of streams; but he nowhere found stratified or even water-classified material enclosed in this formation, except within a few miles of the coast.

The essayist sought to answer the question by considering the processes of melting which take place in a glacier. Strict analogy with existing glaciers — even with those of Greenland — should not be supposed. In modern glaciers, nearly all the water of their lower extremities is sub-glacial. The ice is so broken by crevasses that melting waters soon find their way to the bottom. But a different state of affairs may have prevailed in the continental glacier. Several of these kame rivers are a hundred or more miles in length. Granting all reasonable development of sub-glacial streams, these kames can scarcely be thus accounted for. Superficial water flowing along the surface would gradually deepen its channel: when the melting had so far proceeded that the bottoms of these streams reached the moraine stuff in the lower part of the ice, the kame gravel would begin to gather on the bottoms of their channels. During the final melting, when the condition was such that few if any additional crevasses would be formed, there would be no time to extend the previously formed sub-glaclal channels. The sudden floods would pass over the lowest part of the ice as they would over ground. A great and rapid northward extension of the superficial streams would result.

In discussing this paper, Mr. Upham stated that erosion does not appear in kames. They are not unfrequently a hundred feet in height: one on the borders of the Merrimac river was instanced. They appear to be gravel deposits laid down before the glacier was fully melted.

Relation of the glacial dam at Cincinnati to the terrace in the upper Ohio and its tributaries.

BY I. C. WHITE OF MORGANTOWN, W. VA.

This paper, in the absence of its author, was read by Professor Winchell.

In a paper read before the Boston society of natural history, March 7, 1883, Rev. G. F. Wright showed that the southern rim of the great northern ice-sheet covered the Ohio river near the site of New Richmond, a few miles above Cincinnati; and presented the hypothesis, that one effect of this invasion of the Ohio valley by the glacial ice was to form an immense dam of ice and morainic *débris*, which effectually closed the old channel way, and set back the water of the Ohio and its tributaries, until, rising to the level of the Licking River divide, it probably found an outlet through Kentucky, around the glacial dam. The writer of the essay, after reviewing the evidence, regards Mr. Wright's hypothesis as proved beyond a reasonable doubt. He also claimed, that during the period of the continuance of the dam, the principal tributaries of the Ohio had their valleys filled with sediment carried down and dumped into them by the mountain torrents and other streams which drained the area south from the glaciated region; that subsequently, when the barrier disappeared, the rivers recut their channels through the silt deposits, probably by spasmodic lowering of the dam, in such a manner as to leave the deposits in a series of more or less regular terraces, which in favored localities subsequent erosion has failed to obliterate, though from steep slopes it has removed their every trace. The elevation of this dam at Cincinnati, as determined from the upper limit of the fifth Monongahela River terrace, would be somewhere about 625 feet above low water there in the present Ohio.

In discussing this paper, Professor Lesley said that there were two separate glacial formations to be considered, and the two could not be correlated. The ice-dam could not thus be explained. Professor Wright had discussed the subject with clearness, claiming that the dam was glacial; but at best there were only a few places in the west where the height of the ice could be measured.

The eroding power of ice.

BY J. S. NEWBERRY OF NEW YORK.

THE object of this essay was to enter a protest against the theories of certain geologists who claim that glacial ice has not played an important part in the erosion of valleys. They have undertaken to deny that ice has any great excavating power. Examples of utterances of this school, the speaker said, were to be found in Prof. J. D. Whitney's Climatic changes; in papers by Prof. J. W. Spencer, on the Old outlet of Lake Erie; by Mr. W. M. Davis, on the Classification of lake basins, and the erosive action of ice; and remarks on the same subject by Prof. J. P. Lesley.

The most important heresies which had been advanced in regard to this subject were, first, the denial that there was ever a glacial period; second, if there was an ice period, it was a warm and not a cold one; third, that the phenomena usually ascribed to glacial action in the record of an ice period were generally due to icebergs; fourth, that ice has little or no eroding power, and that glaciers have never been an important geological agent. Professor Newberry proceeded, in controversion of these theories, to give the results of his extended studies of geological action in the Alps and in many different regions of the United States and Canada. These observations lead to the conclusions, 1°. That the glacial period was a reality, and that its record constitutes one of the most important and interesting chapters of geological history; 2°. That this was a cold period; 3°. That ice has a great, though unmeasured and perhaps immeasurable, eroding power; and that, in regions which they have occupied, glaciers have been always important, and often preponderating, agents in effecting geological changes.

No cautious geologist would assert or concede that *all* lake-basins had been excavated by ice, but to deny its influence in their formation would be a far greater error. The basins of our great lakes, and of many of our smaller ones, bear the traces of ice that has moved in the line, at least approximately, of their major axes. The broad, boat-shaped basins indicate the work of this same agency. The islands of Lake Erie are carved from the solid rock: their surfaces and sides, and the channels between them, are all glaciated. The plastic ice has inwrapped those islands, fitting into every irregularity, and carving, with the sand it carried, every surface. The marks of glaciation are to be seen on mountain belts from Canada to Mexico. Even at the present day glaciers are transporting enormous loads. In midsummer the Aar glacier brings down 280 tons per day; the Justedal glacier of Norway wears down, it is estimated, 69,000 cubic meters of solid rock annually. These measurements of the eroding power of two small glaciers should show the fallacy of a denial of the excavating power of ice. Dr. Newberry concluded by citing authorities on the subject.

This paper elicited the most acrimonious discussion of the meeting. Professor Lesley took exception to certain phrases in the paper which seemed to cast a reflection upon the methods of his coadjutors, — men who were conscientiously engaged in scientific investigation, and had seen reason for breaking away from the trammels of opinion formulated by Agassiz and Ramsey. For himself, he did not believe in the theory of erosive glacial processes, and he asserted that there was no good reason for believing that the basins of the great lakes were so produced. He claimed that the basin of Ontario was a Silurian valley; the basins of Erie, Michigan, and Huron, were Devonian valleys. Ice had no more eroding effect than a piece of sandpaper has upon a rough board. He believed in the eroding of water, and represented his idea of the relative power of ice and water, as follows: Ice, 1; rain-water, 10; acidulated water, 100; ice set with stones, 1,000; water set with stones, 10,000.

Professor Newberry disclaimed any intention of attacking the young men of science who were laboring in this field. He re-affirmed the positions taken in his paper. On the other hand, Professor T. Sterry Hunt declared his substantial agreement with the views of Professor Lesley. On account of the length of this debate, the five-minute rule for discussions was adopted and subsequently enforced.

Informal remarks on moraines and terraces.

BY J. W. DAWSON OF MONTREAL, AND J. W. POWELL OF WASHINGTON.

At the opening of the morning and afternoon sessions of the geological section in its last day's work, Dr. Dawson and Major Powell made respectively some informal remarks of interest. Dr. Dawson objected to the loose significance with which the term 'moraine' had been used, and especially to the definition of it as 'detrital matter heaped up by the forcible mechanical action of ice.' He pointed out that such a definition would include work which certainly was not performed by land glaciers.

Dr. Dawson described the glacial deposits exposed along the line of the Canadian Pacific railway, from the Laurentian areas west and north of Lake Superior to the Rocky Mountains, noticing the lacustrine deposit of the Red-river valley, containing only a very few, small, ice-borne stones; the second prairie level covered with Laurentian drift from the north-east, and with an interrupted ridge of scrub material extending along the middle of it, northward from Turtle mountain. He referred to the great Missouri coteau, at an elevation of 2,500 feet, and made up of local mud, and sand, with Laurentian bowlders piled up against the higher prairie steppe; the drift on the surface of this steppe being partly Laurentian and Silurian from the east, and partly from the Rocky Mountains. He finally stated, that huge Laurentian and Huronian bowlders were placed at an elevation of more than 4,000 feet on the foot-hills of the Rocky Mountains, more than 700 miles from their original site. He did not intend to offer any explanation, as investigations into the matter were still being carried on by his son; but he wished to say briefly, that it appeared to him perfectly plain that we could not account for such phenomena as had been described, without taking into account great changes of level, or, without doubt, great submergence and remergence.

Major Powell called attention to the fact, that wholly different agencies, each acting in its own way, produced a class of geological features that went under the general name of 'terraces.' We have sea-beach terraces, lake-shore terraces, and yet another class of terraces exceedingly common in the Rocky and the Cascade mountains. The last-named class of terraces is due to a different cause from the others. Some of this class in the east have been relegated erroneously to the class of beach terraces: those which are said to dam the Ohio, and others found in the Alleghanies, have been formed by a process which can be briefly sketched.

We have a valley. It runs irregularly between bluffs and mountains. We have a force in the river which simply tends down stream; it is itself irregular, its energy depending upon its transient volume and local depth. If the region is upheaved, the river no longer keeps its old course. It seeks the line of least resistance, and may form a new flood-plain below. Then the river, for a while at least, excavates laterally instead of vertically. No longer occupying its old place in the valley, it gradually cuts a new path. But the old terrace may remain. In some places there are more than twenty systems of terraces: In a locality near Pittsburgh, there are fifty-three such systems. These the speaker regarded as chiefly due to changes in the level of the regions, — to elevations and depressions. Further explanation by the speaker was cut short under the five-minute rule.

(*OTHER GEOLOGICAL PAPERS.*)

The earth's orographic framework; its seismology and geology.

The 'continental type,' or the normal orography and geology of continents.

BY RICHARD OWEN OF NEW HARMONY, IND.

These papers were read successively, as being closely related. They refer to a well-known theory of their author, which traces the frame-work of the earth in its mountain chains. He finds such a framework running from east to west in numerous parallel ranges near the equator, and instances those of Sumatra and of South America. This he calls the 'strong girdle' of the earth: it is of mesozoic age, terminating its heights in the cenozoic age. Remotely parallel are the arctic and antarctic belts. Great braces come down to meet this girdle, having at least four ramifications in Asia, starting from the great plateau, and in America forming the great 'backbone' of the continent. The five equidistant continental trends of mountain chains often mark paleozoic belts. But the later as well as the older results tell of strong interior forces that have produced the mountains, and the central belt gives marked evidence that an intense reaction from within aided in its construction.

The similarity of the five great continents has often been the occasion of remark. They seem to have a general plan of construction, that may have been connected with their appearance as land above the ocean. The similarity extends even to their present geographical area. If we cut cross-sections from W. S. W. to E. S. E. through the geographical centre of each continent, we shall find in each case a seismic belt near one rim of the continent, and often near both rims. Thus the continent is usually basin-shaped, and comparatively low in its central area with its chief river drainage, and low near the ocean borders; rising in an eastern and western main range, with usually several parallel subordinate ridges. These eastern and western mountains converge southerly, thus assuming a somewhat irregular form, evolving usually on the west some table-land. The eastern river is usually paleozoic, with perhaps some mesozoic on the flanks and cenozoic on the ocean border. The western elevation is more commonly mesozoic in its main range, and cenozoic in the flanks or subordinate ridges. A section running north and south through the three northern continents would successively expose Cambrian, paleozoic, mesozoic, and cenozoic cuts, which would generally increase in area as we go south.

The papers of Professor Owen elicited, for the greater part, unfavorable comment. It was urged against them, that their generalizations were too broad, and that they were based rather upon closet study than actual observation. As to at least one of the continents, we know as yet far too little of its geology, especially in the interior, to frame a theory of its history and constitution.

The pre-Cambrian rocks of the Alps.

BY T. STERRY HUNT OF MONTREAL, CAN.

THE writer began by reviewing the history of Alpine geology, and noticed first that speculative period when the crystalline rocks of the Alps, including gneisses, hornblendic and micaceous schists, euphotides, serpentines, etc., were looked upon as altered sedimentary strata of carboniferous or more recent times. He then traced the steps by which these views have been discarded, and more and more of these rocks shown to belong to eozoic or pre-Cambrian ages. In this connection the labors of von Hauer, Gerlach, Heim, Favre, Renevier, Lory, Gastaldi, and others, were analyzed; and reference was made to the great progress since the writer in 1872 published a review of Favre on the geology of the Alps.

The sections by Neri, Gerlach, and Gastaldi in the western, and those of von Hauer in the eastern Alps, were described; and it was shown that all these agree in establishing in the crystalline rocks four great divisions in ascending order: 1°. The older granitoid gneiss with crystalline limestones, graphite, etc., referred by Gastaldi to the Laurentian. 2°. The so-called *pietre verdi*, or greenstone group, consisting chiefly of dioritic, chloritic, steatitic, and epidotic rocks, with euphotides and serpentines, including also talcose gneisses, limestones, and dolomites, and regarded by Gastaldi as Huronian. 3°. The so-called recent gneisses of von Hauer and Gastaldi, interstratified with and passing into granulites and micaceous and hornblendic schists, also with serpentines and crystalline limestones. 4°. The series of argillites and soft glossy schists with quartzites and detrital sandstones, including also beds of serpentine with talc, gypsum, karstenite, dolomite, and much crystalline limestone. This fourth series, well seen at the Mont Cenis tunnel, is still claimed by Lory and some others as altered trias; but the present writer's view, put forth in 1872, that it is, like the preceding groups, of eozoic age, was subsequently accepted by Favre and by Gastaldi, and is now established by many observations. To this horizon belong the crystalline limestones of the Apnan Alps, including the marbles of Carrara.

The writer next recalls the fact that he, in 1870, insisted upon the existence of a younger series of gneisses in North America, alike in the Atlantic states, in Ontario, and to the north-west of Lake Superior. These, in his address before the American association for the advancement of science, in 1871, he further described under the name of the White-Mountain series, and subsequently, in the same year, called them Montalban. These rocks were then declared to be younger than the Huronian, and to overlie it; though, in the absence of this latter, it was pointed out that in Ontario and in Newfoundland the Montalban reposes unconformably upon the Laurentian. When these newer gneisses and mica-schists were first described, in 1870, there was included with them an overlying group of argillites, quartzites, and crystalline limestones; and for the whole the name of Terranovan was suggested, provisionally. But in defining, in the following year, the White-Mountain series, this upper group was omitted, and was subsequently referred to the Taconian series,—the lower Taconic of Emmons, and the so-called altered primal and auroral of H. D. Rogers, in eastern Pennsylvania.

The writer next describes his own observations in the Alps and the Apennines in 1881. He affirms the correctness of Gastaldi in referring the groups one and two to Laurentian and Huronian, finds the third, or the younger gneiss and mica-schist group of the Alps, indistinguishable from the Montalban, and regards the fourth as the representative of the American Taconian. It was maintained by Gastaldi, that these pre-Cambrian groups of the Alps underlie directly the newer rocks of northern and central Italy, forming the skeleton of the Apennines, reappearing in Calabria, and, moreover, protruding in various localities in Liguria, Tuscany, and elsewhere. The serpentines, euphotides, and other resisting rocks thus exposed, have been regarded as eruptive masses of triassic and eocene time. The writer, however, holds with Gastaldi, that they are indigenous rocks of pre-Cambrian age, exposed by geological accidents.

The uncrystalline rocks of the mainland of Italy are chiefly cenozoic or mesozoic, and the only paleozoic strata known are carboniferous, the organic forms in the limestone of Chaberton having been shown to be triassic. Triassic, liassic, cretaceous, eocene, and miocene strata are found in different localities, resting on the various pre-Cambrian groups. In the island of Sardinia, however, all these are overlaid by a great body of uncrystalline lower paleozoic rocks, in which the late studies of Bornemann and Meneghini have made known the existence of a lower Cambrian fauna, including Paradoxides, Conocephalites, and Archeocyathus, succeeded by an abundant fauna of upper Cambrian or Ordovian age.

The existence of the younger or Montalban gneiss in Sweden and in the Harz and the Erzgebirge was noticed, and to it were referred the Hercynian gneisses and mica-schists of Gümbel. The presence both in Sweden and in Saxony of conglomerates, as described by Hummel and by Sauer, wherein pebbles of the older gneiss are enclosed in beds of the younger series, was discussed, and the direct unconformable superposition of the latter upon the older gneiss, in the absence of the Huronian, was considered; evidences of the same relations being adduced from the Alps. The gneisses of the St. Gothard, as seen on the Italian slope, were also referred to the newer series; and the important studies of Stapff in this connection were discussed. It was declared that the views put forth by the author in 1870–71, on the relations and succession of the crystalline stratified rocks in North America, and then extended by him to Europe, have been fully confirmed by the labors of a great many European geologists, as already shown. Those of Hicks, Hughes, Bonney, Callaway, Lapworth, and others, in the pre-Cambrian rocks of the British islands, were cited in support of these conclusions. It was said, that, whatever may have been the conditions under which these vast series of crystalline stratified rocks were deposited, there is evidence, in the similarity of their mineralogical and geognostical relations, of a remarkable uniformity over widely separated regions of the earth's surface, as well as of long intervals of time, marked by great foldings and disturbance, and by vast and wide-spread erosion of the successive series of rocks.

In conclusion, the writer took occasion to call attention to the important labors of the present school of Italian geologists, and their great zeal, skill, and disinterested service, as shown in the memoirs of the R. accademia dei lincei, and in the work of the Royal geological commission, including the special studies, maps, and memoirs prepared by it for the International geological congress of Bologna in 1881. The new Geological society of Italy, founded at the same date, gives promise of a brilliant future, and has already published many important memoirs.

The serpentine of Staten Island, New York.

BY T. STERRY HUNT OF MONTREAL, CAN.

THE serpentine of Staten Island appears as a north-and-south range of bold hills rising out of a plain of mesozoic rocks, which on the west side are triassic sandstones like those of the adjacent mainland, including a belt of intrusive diorite, and on the east the overlying, nearly horizontal, cretaceous marls, which are traced south and west into New Jersey. The only rocks besides these mentioned, seen on the island, are small areas of a coarse-grained granite, having the character of a veinstone or endogenous mass, and others of an actinolite rock; both exposed among the sands on the north-east shore of the island.

Mather, who described this locality more than forty years since, looked upon the serpentine as an eruptive rock, related in origin to the parallel belt of diabase which is included in the triassic sandstone to the west. Dr. Britton, of the School of mines, Columbia college, who in 1880 published, in the transactions of the New-York academy of sciences, a careful geological description and map of the island, regarded the serpentine belt as a protruding portion of the eozoic series, including serpentine, which is seen at Hoboken, on Manhattan Island, and in Westchester County, New York, — a conclusion which the writer regards as unquestionably correct.

The appearance of isolated hills and ridges of serpentine is common in other regions, and is by the writer explained by the consideration that this very insoluble magnesian silicate resists the atmospheric agencies which dissolve limestones, and convert gneisses to clay; the removal of which rocks leaves exposed the included beds and lenticular masses of serpentine. Similar appearances are seen in many parts of Italy, where ridges and bosses of serpentine are found protruding in the midst of eocene strata, and have hitherto by most European geologists been regarded as eruptive masses of tertiary age. The problem is there often complicated by the fact that subsequent movements of the earth's crust have involved alike the older crystalline strata (of which the serpentines form an integral part) and the unconformably overlying eocene beds; faulting and folding the latter, and even giving rise to inversions by which the newer rocks, overturned, are made to dip towards and beneath the ancient crystalline masses. This the writer illustrated by reference to localities recently examined by him in Liguria and in Tuscany, where this relation of the serpentines had already been pointed out by Gastaldi. The structure in question was declared to be analogous to that presented by similar foldings and overturns to be seen along the western base of the Atlantic belt throughout the Appalachian valley.

The speaker further alluded to the fact, that, although the sub-aërial decay of serpentine was far less rapid than that of most other rocks, it had not escaped this process; and described the decayed layer on portions of the Staten Island serpentine hills, including a chromiferous limonite segregated from the decayed serpentine. This was a slow pre-glacial process, and in the subsequent erosion of the serpentine ridges the decayed layer has been in parts entirely removed. The details of this decay, and its relations to the limonite, and to glaciation in this locality, have been described by the writer in an essay on the decay of rocks, to appear in the *American journal of science* for September, 1883. He gratefully acknowledged his personal obligations to Dr. Britton for the many facts contained in his memoir and map, as well as for personal guidance during a late visit to Staten Island.

The equivalent of the New-York water-lime group developed in Iowa.

BY A. S. TIFFANY OF DAVENPORT, IO.

THE author stated, that the upper Silurian rocks of Iowa had hitherto been classed wholly as of the Niagara limestone. There has, however, been some dispute as to the magnesian buff-colored limestone of the Le Claire and Anamosa quarries. Such disputes must, of course, be settled by the fossils; but he had been for more than twelve years seeking organic remains in that formation, without success until February of last year, when he found them in considerable quantities. Specimens of the fossils were exhibited. Mr. Tiffany considered that they gave conclusive evidence of belonging to a group higher in the scale than the fossils of the Niagara limestone, that their affinities were with those of the water-lime group of the lower Helderberg, and that the identity of many species had been determined.

Clay pebbles from Princetown, Minn.

BY N. H. WINCHELL OF MINNEAPOLIS, MINN.

THIS paper was accompanied by an exhibition of specimens. The pebbles were of various shapes and sizes, several of them somewhat cylindrical. Outside, they are composed of fine sand and gravel; inside, they consist wholly of a fine sedimentary clay, such as is deposited by standing water, and contain no interior pebbles. Professor Winchell had compared these with pebbles found in till-deposits, and with various others, without finding any thing exactly similar.

Professor Newberry examined the pebbles, and admitted that they were not exactly like any that he had seen, but he thought they bore a general resemblance to pebbles found throughout the range of geological strata wherever there is a bed of sandstone capped by clay. Professor Claypole claimed to have seen similar specimens in Pennsylvania deposits.

The 'earthquake' at New Madrid, Mo., in 1811, probably not an earthquake.

BY JAMES MACFARLANE OF TOWANDA, PENN.

AFTER dwelling upon the fact, that the locality of the alleged earthquake was not the seat of any apparent volcanic action, the author proceeded to state his view that the event in question was due to a different cause. He claimed that the locality was underlaid by cavernous limestones of the St. Louis group. He believed that what took place was a subsidence, due to the solution of underlying strata. He alluded to the descriptions afforded by Humboldt and Lyell, the latter having visited the locality, and given it a careful examination. The inhabitants described it as a convulsion, taking place at intervals during several months, creating new lakes and islands, changing the face of the country. The graveyard was precipitated into the Mississippi river; forest-trees were tilted in all directions; vast volumes of sand and water were discharged on high.

The author claimed that the long continuance of such phenomena, which lasted for several months, was an evidence that they proceeded from mere subsidence, and not from earthquake shock. In respect to the geology of the region, he stated that New Madrid and its vicinity rested on tertiary or quaternary strata. Underlying sub-carboniferous formations are represented near the borders of the depression. The sinking of a shaft brought to light coal, or coal-shales; also there were coaly shales found in the crevices and sink-holes thirty-five years after the so-called earthquake.

This paper elicited strong expressions of dissent from several members. Professor Cox declared that there were no sub-carboniferous rocks in that locality, no caverns, no soluble limestones underlying the surface. The shocks were sudden. There was great destruction of life. No mere subsidence can account for what actually happened. A question as to the truthfulness of the reports from that region brought out very contradictory opinions in the discussion. Professor Cox, who had personally examined the scene of the occurrences, declared that he had found evidences of great disturbance. Professor Nipher suggested that the position of the trees, whether upright or not, which were alleged to be at the bottom of Reelfoot Lake (a lake formed at the time of the earthquake), would help to determine whether a subsidence, or an earthquake, had taken place. Some doubt was expressed as to whether any submerged trees were there. To these doubts and queries, Professor Cox was able to give a definite answer: he had seen the trees still upright beneath the water.

Comparative strength of Minnesota and New-England granites.

BY N. H. WINCHELL OF MINNEAPOLIS, MINN.

HAVING had recent occasion to test the qualities of the building-stones of Minnesota, the author subjected them to the usual tests of crushing, using for this purpose specimens of two-inch cube. The specimens included sandstones, limestones, granites, and trap-rocks, and numbered about 100. Great care was taken in preparing them accurately. They were sent to Gen. Gillmore at Staten Island, and there subjected to the tests, which were applied by crushing the samples, one in the direction of the schistose structure and one across it. The following were the results with twenty samples of Minnesota granites:

Kind of stone.	Location of quarry.	Position.	Strength in pounds. Of sample.	Per cubic inch.
Dark trap-rock, massive melaphyr . . .	Taylor's Falls, Chisago county	On bed .	105,000	26,250
		On edge,	105,000	26,250
Dark trap-rock, from a dyke .	Fischer's creek, n'r Duluth, St. Louis county,	On bed .	105,000	26,250
		On edge,	105,000	26,250
Gray gabbro, massive, fine,	Rice's Point, Duluth, St. Louis county,	On bed .	109,000	27,250
		On edge,	105,000	26,250
Red, fine sienite	Beaver Bay, Lake county,	On bed .	106,000	25,000
		On edge,	103,000	25,750
Red quartzose sienite . . .	Watab, Benton county . . .	On bed .	103,000	25,750
		On edge,	103,000[1]	25,750
Red quartzose sienite . . .	East St. Cloud, Sherburne county . . .	On bed .	112,000	28,000
		On edge,	105,000	26,250
Red quartzite .	Pipestone City, Pipestone county . . .	On bed .	111,000	27,750
		On edge,	108,000	27,000
Massive gray quartzose sienite . . .	East St. Cloud, Sherburne county . . .	On bed .	105,000	26,250
		On edge,	103,000	25,750
Fine-grained gray sienite .	East St. Cloud, Sherburne county . . .	On bed .	112,000	28,000
		On edge,	105,000	26,250
Fine-grained gray sienite,[2]	Sauk Rapids .	On bed .	86,000	21,500
		On edge,	100,000	25,000
Average of	twenty samples,	. . . .	104,800	26,675

Allowing for eleven per cent difference between processes of crushing between steel-plates and between wooden cushions, this gives an average for Minnesota granites of 23,318 pounds.

[1] Estimated. [2] Probably imperfect sample.

The following are the records of tests of New-England granites: —

Kind of stone.	Location of quarry.	Position.	Strength in pounds. Of sample.	Per cubic inch.
Blue . . .	Staten Island, N.Y. .	On bed .	89,250	22,315
	Fox Island, Me. . .	– –	59,500	14,875
	Dix Island, Me. . .	– –	60,000	15,000
Dark . . .	Quincy, Mass. . . .	– –	71,000	17,750
Light . . .	Quincy, Mass. . . .	– –	59,000	14,750
Flagging . .	Hudson River, N.Y.	– –	53,700	13,425
	Cape Ann, Mass. . .	On bed .	59,750	14,937
Porter's rock,	Mystic River, Conn.	On bed .	72,500	18,125
Gray . . .	Stony Creek, Conn. .	On bed .	60,000	15,000
Gray . . .	Fall River, Mass. . .	On bed .	63,750	15,937
Bluish-gray .	Keene, N.H. . . .	On bed .	41,000	10,250
Bluish-gray .	Keene, N.H. . . .	On bed .	51,500	12,875
	Millstone Pt., Conn.	– –	64,750	16,187
	Greenwich, Conn. .	– –	45,200	11,300
Niantic river,	New London, Conn.	– –	50,000	12,500
Niantic river,	New London, Conn.	On edge,	56,700	14.175
	Vinalhaven, Me. . .	– –	52,600	13,150
	Vinalhaven, Me. . .	– –	67,000	16,750
	Westerly, R.I. . .	On bed .	58,750	14,689
	Westerly, R.I. . .	On edge,	59,750	14,937
Average of	twenty granites . . .	. . . . .	59,785	14,940

After discussing several supposable causes of error, and showing that they could not have applied to the present case, the author proceeds to suggest causes why the Minnesota granites may be stronger than those of New England. He thinks those of the west may have been less changed by decay. The lateness of the glaciation to which they were exposed may have left them comparatively fresh through the recent removal of a considerable thickness. On this point we shall be more certain when the glacial moraines have been fully traced from east to west, and the western analogues are determined.

The singing beach of Manchester, Mass.

BY A. A. JULIEN OF NEW YORK AND H. C. BOLTON OF HARTFORD, CONN.

SANDS were taken from the so-called 'singing beach' on the coast of Massachusetts, near Manchester-on-the-Sea, and subjected to microscopical examination. In this beach, the felspathic rocks are intersected by numerous dykes of igneous rocks, among which porphyritic diorite is noticeable. The phenomenon which gives rise to the name of the beach is confined to the portion of sand lying between the water-line and the loose sand above the reach of ordinary high tide. Portions emit the sound; but closely contiguous areas fail to do so, or answer feebly. The sounding sand is near the surface; at the depth of one or two feet it ceases, perhaps because of moisture. The sound is produced by pressure, and may be likened to a subdued crushing; it is of low intensity and pitch, is not metallic nor crackling. It occurs when the sand is pressed by ordinary walking, increases with sudden pressure of the foot upon the sand, and is perceptible upon mere stirring by the hand, or even plunging one finger and removing it suddenly. It can be intensified by dragging wood over the beach.

The authors review and cite very fully the literature of the subject, giving in full a description of the singing sands of the Island of Kaui, one of the Hawaiian group. That gives a sound as of distant thunder, when any thing of weight is dragged over it. Dampness prevents the sound. That sand is calcareous. Hugh Miller cites similar instances at Jebel Nakous in Arabia Petrea, and Reg Rawan near Cabul. Those are silicious sands. The sounds were a sort of humming.

In Churchill county, Nevada, a similar phenomenon is described with regard to a sand-hill, as like the sound of telegraph-wires when wind blows them.

The authors also review and characterize the various sands of different mineral origin.

To explain the sonorous peculiarity of the sand, several theories are considered. That of equality, or of the unequal size of the grains, is rejected. Cellular structure has been supposed, but is not found in the present instance. Effervescence of air between moistened surfaces does not apply to this case. Sonorous mineral, such as clinkstone, is not present. There is no evidence of electrical phenomena being concerned. The hypothesis adopted is that the sand, instead of being, as ordinarily, composed of rounded particles, is made up of grains with flat and angular surfaces. In the present instance, the plane surface of felspar is apparent in many of the grains. Probably a certain proportion of quartz and felspar grains is adapted to give the sound, while less or more of either component would fail of the result.

Dr. Bolton has himself examined a sand of similar quality, on the island of Eigg in the Hebrides, and has described its properties. That is largely calcareous. Its constitution is a mixture of large and small grains, the larger ones being rounded quartz. Many small, angular fragments of quartz are also contained, and many dark granules of chert, the last being about three or four per cent of the whole, and having a cellular structure.

It is concluded, that the sound is produced either by the intermixture of grains having cleavage planes, or of grains with minute cavities. The paper ends with a table of the physical structure of the sands of many localities.

(*PALEONTOLOGICAL PAPERS.*)

Preliminary note on the microscopic shell-structure of the paleozoic Brachiopoda.

BY JAMES HALL OF ALBANY, N.Y.

IN the earlier studies of the Brachiopoda, the numerous species were referred to few generic terms, determined from their perforated apex and external form, and later from the study of the interior as these became known. The author said, that from time to time, as these characters had become known to him from the study of large collections, he had found it necessary to propose the separation of eighteen new generic forms from those previously known in this class of fossils. Other authors had also proposed new generic terms, until the list had become many times greater than it was twenty-five years ago.

While the interior structure of the hinge, and the muscular and vascular markings, were now pretty well known for most of the generic forms in use, comparatively little attention had been given to the minute structure of the shell. Little more had been done than to show that some forms possessed a punctate and others a fibrous texture.

The study of this structure had been commenced by him many years ago, but he had been thwarted in his efforts to procure the required cutting and polishing of specimens of the shells for microscopic study. He had now been able to obtain such thin slices of the shell as were required for this purpose, and had already several hundred slides prepared for the microscope.

A few of these only were shown, exhibiting the shell structure of as many genera. A considerable number of photographs had been made, illustrating, in a very satisfactory manner, the minute structure of each one, enlarged to twenty diameters. The photographs exhibited were illustrations of several species of Orthis, Leptaena, Strophomena, Strophodonta, Chonetes, etc.

The study of this shell-structure has shown very satisfactorily, what was partially known before, that the genus Orthis, as now defined and constituted, includes very heterogenous material. External form, hinge characters, and interior muscular impressions, have been the chief guide; and yet forms have been included under this genus, showing widely different muscular markings. On further microscopic study, it has been found that these differences in form of muscular imprints are accompanied by important differences in the shell structure.

These differences may be noted in the illustrations presented, where the shell of Orthis biforata, O. borealis, O. tricenaria, O. occidentalis, O. flabella, are non-punctate and coarsely fibrous. Orthis (?) strophomenoides is, like Streptorhynchus, fibrous. Orthis subquadrata has, like O. occidentalis, a few large punctae.

In the second group, Orthis testudinaria, O. Vanuxemi, O. perveta, O. penelope, O. elegantula, O. clytie, and O. hybrida, have one or more rows of punctae to each ray, the rows well defined, and the intermediate shell finely fibrous.

The third group, consisting of Orthis multicostata of the lower Helderberg, O. jowensis of the Hamilton group, O. tulliensis of the Tully limestone, O. impressa of the Chemung group, are highly punctate with a fine fibrous texture of the shell substance.

The punctae usually come out along the summits of the radiating striae or plications of the shell. In some species the minute tubes perforating the shell, and producing these punctae, bifurcate and diverge before coming to the external surface of the shell.

This difference in shell structure, in forms known as Orthis, will require a separation of the species into groups based upon the shell structure, and character of muscular impressions. Already we see that the shells of compact fibrous texture have a form of muscular impression quite unlike those with the punctate structure; and we shall probably find that all the interior modifications of the muscular system are accompanied by differences in the microscopic structure.

This method of determining the shell structure, in cases where the specimens may be imperfect, and thereby enabling the determination of obscure or fragmentary material, and its geological relations, will be of much importance to the geologist.

The structure of the shell in Strophomena is closely fibrous, with distant large punctae. In Strophodonta, the punctae are more numerous. In Chonetes, the punctae are large, and arranged parallel to the radii, having a pustulose aspect.

In many other forms, the punctate texture of the shell is characteristic, and of importance in the determination of the generic forms.

The physiological significance of this peculiar shell structure will be considered upon some future occasion, illustrated by more numerous examples.

Rhizocarps in the paleozoic period.

BY J. W. DAWSON OF MONTREAL, CAN.

THE author referred to a previous memoir, entitled 'Spore-cases in coal,' published in 1871. This described fossil remains in a shale from the Erian formation at Kettle Point, Lake Huron, supposed to be on the horizon of the Marcellus shale of New York. The remains are minute brownish discs scarcely more than one-hundredth of an inch in diameter. They were recognized as probably spore-cases or macrospores of some acrogenous plant. The shale also contains vast numbers of granules, which may be escaped spores or microspores. In 1882 Dr. Dawson's attention was called to the discovery of similar bodies in vast numbers in the Erian and lower carboniferous shales of Ohio. The discoverer, Professor Orton, regarded these bodies as spore-cases, and as the chief source of the bituminous matter in those shales. Professor Williams found similar bodies in the Hamilton shales of New York; and Prof. J. M. Clarke, in the Genesee shale and in the corniferous limestone. The last named are of larger size than the others.

No certain clew had been thus far afforded to the affinities of these widely distributed bodies. But last March, specimens were found in the Erian formation of Brazil, by Mr. Orville Derby, which threw new light on the subject, containing as they did, along with the Sporangites, abundant fronds of Spirophyton. The Sporangites of Brazil resemble in every respect the involucres or spore-sacs of modern rhizocarps, and especially the sporocarps of the genus Salvinia.

Dr. Dawson describes with technical exactness two leading types which he has named provisionally Sporangites braziliensis and S. bilobatus. The paper offers the suggestion that these plants, now so insignificant, culminated in the paleozoic age, and, occupying the submerged flats of that period with abundant vegetation, produced a great quantity of the bituminous matter found in resulting beds. A rich rhizocarpean vegetation in the early paleozoic and eozoic ages may have preceded the great development of acrogens in the later paleozoic.

In the discussion which followed. Dr. Dawson disclaimed any intention to assert that the Sporangites were the sole source of the bituminous matter.

Rensselaeria and a fossil fish from the Hamilton group of Pennsylvania.

BY E. W. CLAYPOLE OF NEW BLOOMFIELD, PENN.

THE Hamilton sandstone of Pennsylvania is found in ridges just before we come to the Blue Mountains. The sand tapers off from a centre in these ridges both ways. At places it is eight hundred feet in thickness, some of it quite hard and flinty. Perhaps this sand was left by rivers; but, at all events, where it is missing it must have been cut away by erosion. The author believed that an ancient river had occupied nearly the place of the present Susquehanna, but running in an opposite direction, — to the north, — and probably debouching where the city of Harrisburg now stands. That locality had previously been below the sea: it was raised so as to become dry land through which this river runs. That land and that river again sank slowly. Then the sunken land received sand from the river. Afterward this region became the bed of a sea. It is a fan-shaped deposit, thickening toward the centre of the fan.

The author exhibited a model of a fish whose remains were discovered in this sandstone. He also showed specimens of alleged Rensselaeria found in the Hamilton sandstone. The latter were shown to Prof. James Hall, during the reading of the paper. Mr. Claypole thought them identical with the Rensselaeria of the Oriskany sandstone, there being a difference of a thousand feet between the two horizons; and he believed this the first instance of such discovery. The strata were tilted on edge in the locality where the fossils were found. Mr. Claypole made a diagram of the geological structure of the region. The fossils were in the middle of the sandstone, which is six hundred to eight hundred feet thick. A Spirifer very much like S. formosa is found there in great quantities.

Professor Hall, after a brief examination, said that anybody was excusable for supposing the fossils to be Rensselaeria. The differences between them and the Oriskany fossil were slight though well marked. Professor Hall described some of these differences, and Mr. Claypole acknowledged that a certain V-shaped groove was wanting in his specimens. Professor Hall thought that possibly the fossils should be referrred to Amphigenia, which had many similarities to Rensselaeria. Professor Newberry thought the fish fossil new.

A large crustacean from the Catskill group of Pennsylvania.

BY E. W. CLAYPOLE OF NEW BLOOMFIELD, PENN.

OF this fossil the author exhibited a cast. It showed no evidence of fish structure. Its apparent affinities were with the king crab, yet it was not a true Limulus nor even a limuloid. A cast in gutta-percha was also shown, which better exhibited the markings. There was a resemblance in the fine surface-marks to Eurypterus. But the eurypterids, with a single exception, were all found in strata vertically distant six thousand feet.

Professor Hall said that the eurypterids were widely distributed. They were found in the coal-measures, in the Waverly sandstone, and perhaps — though that was not quite certain — in the Portage group.

Animal remains from the loess and glacial clays.

BY WILLIAM McADAMS OF ALTON, ILL.

THE drift clays proper at Alton, Ill., had a maximum thickness of about one hundred feet, and the bluff clays were nearly of the same thickness. These clays were remarkably rich in animal remains, such as teeth and bones, attached to calcareous nodules or claystones. Remains of thirteen different species, now perhaps all extinct, had been found. The rodents were well represented in the bones of seven species, including three or more beavers and some gophers. Nearly seventy teeth were found in the quaternary deposits, a majority of them in a single quarry.

A new vertebrate from the St. Louis limestone.

BY WILLIAM McADAMS OF ALTON, ILL.

ONE of the groups of subcarboniferous limestone is quarried extensively near Alton and St. Louis. It lies beneath the coal, and in some places the coal rests directly upon it. A number of vertebrate remains have been found in one of the quarries near Alton. Specimens were shown by the author of the paper. In the judgment of Professor Newberry, the fossils shown were the bones of some large fish. One appeared to be the mandible or dental bone of the lower jaw. Without pronouncing a final opinion, he would say that it bore a general resemblance to a group of fossil fishes in which the teeth were inserted in sockets; but the animal itself was large and hitherto unknown.

List of other papers.

The following additional papers were read in this section, some of them by title only: Thermal belts, by *J. W. Chickering*. The Hamilton sandstone of middle Pennsylvania, by *E. W. Claypole*. Evidences from southern New England against the iceberg theory of the drift, by *J. D. Dana* [this paper will appear in full in SCIENCE]. Topaz and associated minerals from Stoneham, Oxford county, Me.; Colored tourmalines and lepidolite crystals from a new American locality; A note on the finding of two American beryls; Andalusite from a new American locality; On a white garnet from near Hull, Canada, — by *G. F. Kunz*. The genesis and classification of mineral veins, by *J. S. Newberry*.

PROCEEDINGS OF SECTION F.—BIOLOGY.

ADDRESS OF W. J. BEAL OF LANSING, MICH., VICE-PRESIDENT OF THE SECTION, AUG. 15, 1883.

AGRICULTURE: ITS NEEDS AND OPPORTUNITIES.

Instead of presenting a summary of the progress made in biology during the past year, I have chosen, rather, to speak of the 'Needs and opportunities of agriculture,'—a subject which has heretofore scarcely been mentioned at the meetings of this association. Within the past few years the progress of agriculture, which I use in its broadest sense, has been greater than ever before. This may be attributed to a variety of causes; such as the general thrift and intelligence of our people, and the advancement of science.

Many agricultural schools have been established, experiment-stations organized, the rural press has been much improved in quality and quantity, clubs and societies are flourishing, and thousands of granges have helped to stimulate thought and investigation. Though there is much chance for improvement, the U. S. department of agriculture in several of its sections has done excellent work. It is true, and it is strange that it should be true, that, until within a comparatively recent period, but very little of the best thought, even of civilized nations, has been devoted to subjects intended to advance agriculture.

Columella, eighteen hundred years ago, keenly felt the want of more thought in agriculture when he said, "Husbandry alone, which, without doubt, is next to, and, as it were, near akin to, wisdom, is in want of both masters and scholars. Of agriculture, I have never known any that professed themselves either teachers or students." Many of our states have freely appropriated money to conduct surveys in geology, mining, with a little attention given to zoölogy and botany, not neglecting to provide liberally for coast-surveys.

The nation, considering its age, has also been very generous with money in support of surveys of various kinds, including, also, anthropology, construction of lighthouses, improving rivers and harbors, investigating the supplies of fish, and even astronomy has been generously supported. It is true that some of this work performed by the government has been very poorly done, and has been enormously expensive; but the methods of work are improving.

This munificence of the United States in support of science is encouraging, and, as far as it goes, speaks well for the country and our law-makers. Doubtless, in many cases, the close connection with politics is one great hindrance to successfully conducting investigations in science for the government. The chances of losing positions are often too great to make them desirable, especially to persons who dislike political contests. Frequent changes are fatal to good, long-continued work.

Notwithstanding the large sums of money expended by our national and state governments in support of science, but a small sum, considering its importance, has been appropriated in the interest of agriculture. Even private gifts have gone to endow literary colleges, schools of physical or natural science, astronomical observatories, public libraries, and not to endow something which is directly intended to encourage agriculture. The men like Lawrence, Sheffield, Smithson, Peabody, Washburn, Swift, Stevens, are numerous, but not numerous enough. All honor to the noble names of those who have so generously contributed to the advancement of science.

To illustrate the hesitancy of men to bequeath money for the promotion of agriculture, I take the following from an address given by President T. C. Abbot:—

"I met a very pleasant and intelligent gentleman, who, from his large wealth, was about to give some sixty or seventy thousand dollars for the advancement of higher education. He had been for some years, and was still, the president of a state agricultural society. He was a farmer. Did he then endow some chair of agriculture, or agricultural chemistry, of veterinary science, of horticulture? Did he fit out an experiment-station to analyze fertilizers, to study the value of cattle-foods? Did he establish an agricultural library? None of these. He found the science that was the most advanced of any, the one that government supports at a great expense from the public treasury. This farmer gave his thousands to endow another workshop of astronomy."

Yet, even in respect to private endowment, there are approaching signs of better days for agriculture. A few far-seeing men have observed the needs of this interest, and have set a noble example by giving of their wealth bounteously. Cornell, Bussey, Purdue, Valentine, Storrs, in this country, are names which will long be honored for liberal gifts in the interest of agriculture. They showed great sagacity, and not a little originality, by placing endowments in a new field, where gifts are few, and the opportunities for good are boundless. It is hoped that these illustrious examples will stimulate others to make similar bequests.

Where agriculture thrives, there we always find a prosperous people. She needs more trained minds to work in her interest. With better thought would come great and needed improvements in the agricultural department of the nation. It lacks means, strength, and stability.

The matter of plans, and the naming of a competent director of the geological survey, was referred to the National academy of sciences, whose suggestions the government authorities sought and adopted.

The same body, or the standing committee of this association, or the members of the Society for the promotion of agricultural science, would be amply competent to name a good man for commissioner of agriculture. Such a plan would throw the position more out of politics, and it would be more likely to run smoothly on, like the work of the Smithsonian institution.

Greater permanency would tend to make the department more efficient, and help it to co-operate with the agricultural departments of the several states and the agricultural colleges and experiment-stations.

The leading object of these remarks is to call the attention of those who are working for the advancement of pure science to the great needs of agriculture, the grand opportunities for making discoveries, and the lasting gratitude which such workers are likely to receive from the people. Of course, we grant that all science is valuable, that much of pure science has a practical bearing, that no one can foretell what practical results may be reached by investigations in pure science; still there is a tendency among scientific men to ignore economic science.

I will illustrate my meaning. The U. S. signal-service is generally supposed to have been established in the interest of science, with the avowed intention, also, of benefiting navigation. The benefits in these respects are certainly worth all they cost, but these are not all the benefits which the service should recognize.

I note the following as given by Dr. R. C. Kedzie some months ago, to illustrate the tardiness of science and the government to promptly grant assistance to the interests of agriculture.

"No industry, except navigation, is so completely at the mercy of the weather as agriculture, in its widest sense. In the magnitude of the interests thus threatened, agriculture outweighs all others in importance. Indeed, without the sustaining influence of agriculture, commerce itself would vanish like the dew of morning. Timely warnings of impending meteorological dangers might be given by the signal-service, which would be of incalculable worth to agriculture."

He illustrates the subject by referring to the protracted rainy weather during the wheat-harvest of 1882, in Michigan, where the loss was very great. "The approach of a protracted storm was known for days before the damage was done. If specific warning had been given our farmers at that time, most of the wheat might have been safely housed, and the farmers of Michigan saved from a loss of more than $1,000,000. The damage inflicted in this way is not isolated and exceptional."

At length the growers of cotton and tobacco in the south, and of cranberries in New Jersey, have been recognized by the government, and warnings of approaching frosts have been promptly given. "The general government, through the signal-service, should hold the shield of its protection over land as over sea, over corn-field as over tobacco-plant, over hay-field as over cranberry-marsh, over wheat-field as over cotton-plantation, over orchards and vineyards, and the cattle upon a thousand hills and prairie leas. Why not extend this work into wider fields by doing for the *producer* what it has so well done for the *carrier?*"

The opinion seems to be too prevalent that few experiments in agriculture are worth attempting, unless it be those conducted by a chemist. This is by no means the case, though it is true that none but a chemist is capable of making those of a certain nature. A physicist will still find in the soil much to interest him, and there is, no doubt, a chance to make discoveries valuable to agriculture.

With regard to the great importance of investigations and united action concerning the control of various plagues of our domestic animals, we should suppose no one would give a dissenting voice. Some valuable investigations have been made concerning the cause and nature of these diseases, among the most interesting of which, it seems to me, are the experiments made by Dr. Salmon in using an attenuated virus for inoculating animals, and inoculating again and again with a stronger virus those not affected by the attenuated virus. If the subject of animal plagues and the means of controlling them were fully discussed at meetings of this association, it would tend to allay prejudice, enlighten the minds of our citizens, and stimulate our law-makers to action. That there is need of a more general knowledge of this subject, I quote from a recent article by Professor Law in the proceedings of the Society for the promotion of agricultural science. "The present agitation on behalf of legislation for the extinction of this lung plague in America began actively in 1878, and, notwithstanding that the subject has been continually before federal and state legislators for four years, but little real progress has been made. Among the drawbacks that may be specially named is the ignorance of legislators, of executives, and even of electors, on this subject."

In learning how to economically feed domestic animals, there is a great opportunity for investigation. There is much of interest and value to be learned in reference to the causes of fluctuation in weight of animals which are carefully fed and watered in a uniform manner.

Concerning the great need of continued and increasing efforts to investigate our injurious and beneficial insects, I need say but little; for the subject has been kept before the people, and the people are always interested to know something about an insect as soon as it injures their crops, or causes them trouble in any way. There is especially much need of more experiments to find better remedies for injurious insects. Attention to this portion of the subject cannot fail to meet with some degree of success. Success here is sure to win the gratitude of every one engaged in agriculture. Success in finding good, cheap, and safe remedies for injurious insects will tend to make science popular, and make endowments for research much easier and more frequent than ever before.

I need hardly add, that he who finds or breeds a race of honey-bees which is hardier, more industrious, longer-lived, quieter, possessed of longer tongues, and, last but not least, possessed of blunter stings, with less inclination to use them, — he who can succeed in any or all of these objects is entitled to rank with the man who shall cause two blades of grass to grow where only one grew before.

The U. S. commission on fish and fisheries is an example of good scientific work, with prospects of early returns in the form of an increase in knowledge and a large increase in the supply of fish. A somewhat similar work, conducted by Prof. S. A. Forbes of Illinois, is in progress, where the object of the survey is to inquire into the food of birds and the food of fishes.

Some valuable scientific work of an economic nature has been done in connection with the tenth census, conspicuous among which is that performed by Prof. C. S. Sargent, in the study of forestry.

Botanical explorers in every land have repeatedly and liberally contributed plants of economic importance to the horticulturist, — a few new fruits, but more especially flowers and foliage-plants. An occasional contribution has been made to agriculture in the form of plants which promised to be of value for seeds or forage, or for some other purpose.

I have often been surprised that more attempts had not been made to secure the introduction of some new foreign grasses, and test them to ascertain their value for meadows and pastures. To be sure, grasses from western Europe have been tried; but we need others.

More than twelve years ago this idea appeared in my address on grasses, as given before the Northwestern dairymen's association, where the advice was given to get other grasses from Japan, China, central Asia, and the dryer portions of South America. The cereals and pasture-grasses, the world over, are of more value to man and his domestic animals than all other plants taken together; yet the list of pasture-grasses now generally sown in any state can be counted on the fingers of one hand. In Great Britain, where much attention has been given to the subject, twenty-five or thirty species are much cultivated. It is hard to give all the reasons why so few grasses are employed in this country; but the fact remains, that few are cultivated. The grass family is a large one, containing from thirty-one hundred to four thousand or more species. They are widely distributed in nearly all parts of the habitable globe, in every soil, in society with others, and alone. This does not convey an adequate idea of their value in unwooded regions, because the number of individuals of several of them is exceedingly large.

I have recently found the following in the *American agriculturist* for 1858, a statement probably made by Dr. Thurber. "A dozen sorts, probably, cover nineteen-twentieths of all the cultivated meadow-land from Maine to Texas. It can hardly be supposed that so limited a number meets, in the best manner possible, all the wants of so great a variety of soil and climate. This is one of the pressing wants of our agriculture. Experimental farms are needed where the value of new grasses and kindred questions can be determined. A single new grass, that would add but an extra yield of a hundred pounds to the acre, would add millions of dollars annually to the productive wealth of the nation."

Still farther back, in 1853, the late I. A. Lapham of Wisconsin expressed similar views; and still longer ago, in 1843, forty years ago, in a prize-essay, J. J. Thomas said, "The great deficiency in the number and variety of our cultivated grasses has been long felt by intelligent cultivators." In this subject, but very slow progress has been made in forty years.

In the extensive unwooded regions west of the Mississippi, the native grasses afford much pasture; but many of them start very late in spring, and stop growing early in autumn. They do not completely occupy the ground: they are easily stamped out by the hoofs of cattle and sheep. Some of the tame grasses will thrive better, and afford much more pasture.

In Science, vol. i. p. 186, of this year, Prof. N. S. Shaler refers to this subject. He says, "It seems possible to improve this pasture by the introduction of other forage-plants indigenous to regions having something like the same climate. The regions likely to furnish plants calculated to flourish in a region of low rainfall include a large part of the earth's surface. Those that would succeed in Dakota are not likely to do well in Texas or Arizona. For the northern region, the uplands of northern Asia or Patagonia are the most promising fields of search; while for the middle and southern fields, the valley of the La Plata, southern Africa, Australia, and the Algerian district, may be looked to for suitable species." He recommends three experiment-stations, — one in Nebraska, one in Texas, and one in Arizona.

In this connection, when we remember that exotic plants often thrive better than natives, we see what a vast field lies ready for experimenting with the grasses.

Grasses look much alike to all who have not closely studied them; so that farmers — in fact, none except botanists are likely to attempt experiments. This is a strong reason why the state and national governments should assist agriculture in an undertaking which seems so fruitful of good results within a short time, at so trifling an expense. Expeditions are sent at great expense to explore polar seas, with a view to slightly extending our knowledge of a barren portion of the earth's surface. Large sums are employed to fit up in magnificent style, and send to the remotest parts of the earth, expeditions to spend a few minutes in observing an eclipse or a transit of Venus. Would the sending of competent persons around the earth in search of better grasses be an undertaking less praiseworthy?

The men who control the Northern Pacific railway were enterprising enough to see that a complete economic survey of the adjacent territory would help the sale of their lands. Among other things, the grasses will be carefully examined.

For the past ten years the writer has been testing, in a small way, some hundred and fifty species of grasses. These, with few exceptions, are natives of the eastern United States and western Europe. I am fully convinced that further experiments, carefully made on a larger scale in several portions of our country, will be quite sure to result in great gain to agriculture.

Grasses suitable for the western prairies, to take the place of those which will be rapidly stamped out by close feeding, are sure to be found even without the aid of the government; but greater time will be required.

Prof. E. M. Shelton of Kansas agricultural college has probably done more than any one else in the west to test grasses and clovers, and diffuse information in regard to the results, which are most gratifying. At nearly all gatherings of farmers in the west, this question of new grasses is a prominent topic of discussion.

Wherever irrigation has been well tried, especially on land which is light and well drained, the results have been quite surprising, converting a dry, hungry meadow into a little oasis. Such a meadow is the triumph of agricultural art.

One of the most remarkable results of irrigation, as viewed by a scientific man, is this: the list of grasses will not remain the same, or maintain the same proportion. The bad grasses will nearly all die out, or improve in quality; while the best ones will rapidly increase. And again: experiments in England have shown that irrigation causes many herbaceous plants, distinct from grasses, such as plantain and buttercups, to give place to good grasses. Docks are not diminished by irrigation. The best grasses are a sign of good land in fine condition. Such grasses are hearty feeders, and are most sensitive to good treatment. In a well-managed meadow, irrigation in four years increased the value threefold.

Solon Robinson long ago expressed the view, that, if the streams of Connecticut were properly utilized in irrigating the soil, they would be more productive in value than by turning all the water-wheels of the state. More experiments in irrigation are much needed in this country.

Baron J. B. Lawes, a most renowned experimenter in agriculture, possessed an old pasture having been in permanent grass over a century. No fresh seed of any kind was sown during this period. For some seven years or more, he experimented by applying to this old pasture, on different plats, twelve different kinds of manures. The results were very interesting and gratifying. "The manures, which much increased the produce of hay, at the same time very much increased its proportion of graminaceous herbage. The total miscellaneous herbage (chiefly weeds) was the most numerous in kind, and nearly in the greatest proportion, on the *unmanured* land, — viz., sixteen per cent, — while on the manured plat it decreased to two per cent. Every description of manure diminished the number of species and the frequency of occurrence of the miscellaneous or weedy herbage. A few weeds were increased by the manures, such as Rumex and Achillaea."

"The plants of a meadow," in the words of the *Agricultural gazette*, "live in harmony on the unmanured open park, having nothing to fight for in a state of nature; but toss them a bone, ground fine, or any other choice bit, and their harmonious companionship terminates at once. Every act of improved cultivation occasions instant war. A grass likes the best that can be got. It will swallow soda, but not when it can get potash. As a general principle, all manures tend to drive out the weeds by increasing the better herbage." A repetition of like experiments in this country could not fail to give valuable results.

In Europe some success has been reached in selecting and cultivating different varieties of Lolium perenne, Dactylis glomerata, and Trifolium pratense.

The field is a promising one for any careful and enthusiastic student. For three years past, I have been studying hundreds of plants of red clover at all seasons and stages of growth. I have plants growing, the seeds of which came from marked plants which varied much from each other. Plants in the fields of red clover vary amazingly in many respects, which influences their value for forage-crops. I believe our fields of red clover to-day contain nearly or quite as great a variety of plants as would a field of Indian corn, if we were to mix in a little seed of all the varieties cultivated in any one state.

Some of our grasses in cultivation are quite variable, notably the fescues, orchard-grass, and perennial rye-grass. It was some time ago observed that alfalfa of California, and lucerne of Europe, were quite different in their capacity to endure dry weather, though they belong to the same species. Different treatment in widely separated countries for many years has wrought a great change.

The subject of changing seed, planting old seed, mixing seed, raising it one year or more in a remote country, and then returning to the starting-point, deserves the attention of careful experimenters.

The late Charles Darwin experimented on the effects of cross and self fertilization of plants, and found that in most cases plants from crossed stock were earlier, hardier, germinated better, and yielded more seeds, than those from seed of self-fertilized plants, while crossing with foreign stock of the same variety is a far greater improvement. The idea is to cross the flowers of a plant with pollen from other plants of the same variety, the seeds of which were raised pure for five or more years in a remote locality, fifty miles or more away.

Mr. Darwin said, "It is a common practice with horticulturists to obtain seeds from another place, having a very different soil, so as to avoid raising plants for a long succession of generations under the same conditions; but, with all the species which freely intercross by the aid of insects or the wind, it would be an incomparably better plan to obtain seeds of the required variety, which had been raised for some generations under as different conditions as possible, and sow them in alternate rows with seeds matured in the old garden. The two stocks would then intercross, with a thorough blending of their whole organizations, and with no loss of purity to the variety; and this would yield far more favorable results than a mere exchange of seeds."

In a word, with plants which may be easily crossed, get some foreign seed of the same sort to mix with your own seeds to raise seeds for ensuing crops.

In 1877 I began some experiments of this kind with Indian corn and with beans, and have since made others. The advantage shown by crossing of corn over that not crossed was as 151 exceeds 100, and in the case of black wax-beans it was as 236 exceeds 100. Since then similar experiments have several times resulted in showing a large increase in favor of crossing with foreign stock.

In a review of Darwin's book, the *Gardener's chronicle* of England said in 1877, "It is certain that these practical results will be a long time filtering into the minds of those who will eventually profit most by them." The results of my experiments have been widely printed in the agricultural papers of the day, and have been given at numerous farmers' institutes and granges, beginning in the winter of 1877, nearly six years ago; and yet I cannot learn that any other person in this country has attempted similar experiments. I will make one exception, in case of Prof. W. A. Henry of Wisconsin university, who tried the experiment in connection with myself. The results, so far, fully accord with the prophetic statement above quoted from the *Gardener's chronicle*.

In originating new varieties and races, see what has already been done, largely in our own country, in a haphazard way, with strawberries, raspberries, blackberries, gooseberries, and grapes, to say nothing of improvements in ornamental plants.

I need hardly add, that some of the best results, considering the time and means employed, have been obtained by persons who have crossed and hybridized according to some well-devised plan.

Our varieties of fruits in cultivation have become so numerous, that to describe them by the fruit and foliage alone often baffles the skill of the most expert pomologist. In the proceedings of the American pomological society for 1877, 1879, and 1881, I have shown that much help can be obtained by noticing the peculiarities of the flowers of apples and pears. The same is no doubt true, to some extent, with grapes, peaches, gooseberries, and other fruits.

Here is a promising field, full of interest to the botanist, — a field where he may accomplish much to aid the horticulturist, and something to advance science. A new variety of any cultivated fruit can no longer be considered as well described, unless some account be made of the flowers.

It has often been shown that many kinds of insects are beneficial to plants by aiding the fertilization of the flowers. The subject has still about it much that is new. Even Mr. Darwin said he did not suppose that he fully understood all the contrivances for fertilization in any one flower.

If it be true, as my experiments during the past six years help to indicate, that bumble-bees aid in fertilizing red clover, then farmers should try to encourage these interesting insects, even though they be disagreeable companions. Bumble-bees prefer to raise their colonies in old nests of meadow-mice. I mentioned in my last report, that it had been suggested that we should not keep many cats, nor allow hawks, foxes, or dogs to catch these mice; for they make nests which are quite necessary for the bumble-bees, which help fertilize our red clover, and thereby largely increase the yield of seed.

Perhaps it may not be altogether visionary to predict that men will yet engage in raising bumble-bee queens, and sell them to farmers at a fair profit, for starting colonies to improve the yield of clover-seed. We may yet have conventions and societies where the leading object shall be to discuss the merits of different sorts of bumble-bees.

A few years ago experiment-stations in Europe began testing seeds which were offered for sale in the markets. Adulterations were discovered most ingenious in character, harmful in effect, and remarkable in amount.

The more the subject was investigated, the worse it seemed to be. Something of the same sort has been undertaken in this country, showing that even in Michigan some worthless seeds are put on the market. In 1877 and later I tested large numbers of vegetable-seeds purchased of fifteen of our large dealers and growers. Not one of these is free from selling seeds that are worthless. The remedy is not easy. On account of its effect on their advertising, publishers are unwilling to print for their readers the results of these experiments. Only a few people can acquire the information after experiments are made.

In making tests of seeds, we still lack information in regard to the surest and best mode of testing each sort. Here is a good work for some accurate and ingenious scientist to invent new apparatus, learn the proper amount of heat, air, and moisture, for producing the best results, find out whether seeds will thrive best with a constant temperature, or a variable temperature; and learn the best modes of preserving seeds alive from one year to another.

I need hardly mention to intelligent students, that there is an extensive field, a very attractive one, in the study of fungi. The agriculturist who deals with plants, not only wants to know the kinds, but the requirements which are favorable or unfavorable to their development. In the study of effectual remedies against fungi, something has been done; but there is still much demand for more knowledge. Successful experiments in regard to fungi are not likely to be made except by botanists.

I have only glanced at a few points where the biologist can find interesting work which will give threefold returns by advancing science, helping to elevate agriculture, and benefiting our country. There are many experiment-stations in Europe, and some in this country. We hope their number may soon increase, and that liberal and permanent endowments will not be lacking. This association, and all other societies working in the interest of science, can render a great service by doing what they can to encourage experiments in all departments of agriculture. Men can be encouraged to prepare papers, and committees can make reports pertaining to the subject. There is a need of thorough state surveys, solely with a view to the interests of agriculture and kindred subjects. More knowledge of our soils, water, building-materials, plants, timber, injurious fungi, insects, and birds, would return to a state, fivefold the cost of acquiring such information. In brief, then, as one of the humble workers in the interests of agriculture, I most cordially invite you to turn your attention to some of the problems which vex the husbandman.

PAPERS READ BEFORE SECTION F.

On the use of vaseline to prevent the loss of alcohol from specimen jars.

BY B. G. WILDER AND S. H. GAGE OF ITHACA, N.Y.

In the absence of the authors of the paper, an abstract of it was read by the secretary of the section, Professor Forbes. Vaseline, when used for the purpose indicated, proves to be an agent unaffected by temperature, and by most chemical substances. It is sparingly soluble in cold alcohol, but wholly soluble in hot alcohol, solidifying on cooling. It can be fitly applied in sealing specimen-jars, and meets many requirements when so used.

A new plan of museum-case.

BY E. S. MORSE OF SALEM, MASS.

The author described, and exhibited by means of drawings, a new plan of museum-case. He said his observations in the museums of Paris proved the great inferiority of the cases there to those in the United States. He gave, in addition to a detailed plan of a case, some suggestions as to the best method of arranging articles within. Mr. Morse has had the subject of arrangements for museum exhibitions under consideration for several years, and the present plan includes contrivances which he has previously suggested as separate devices.

(*BOTANICAL PAPERS.*)

A supposed poisonous seaweed in the lakes of Minnesota.

BY J. C. ARTHUR OF CHARLES CITY, IO.

In the summer of last year many cattle and hogs died in the vicinity of Waterville, Minn. Residents in the locality believed that the animals were poisoned by drinking the water of adjoining lakes. There are two lakes of considerable size in the neighborhood: they are free from marsh, and have wooded borders; through them runs a somewhat sluggish river.

At the time of the occurrence, the lakes showed a quantity of dark-green scum on the surface, as well as disseminated through the water. The surface-layers of the scum were in places several inches thick. The scum proved to be a water-weed, having some characteristics like those of the nostoc, but is known to botanists as Rivularia fluitans, and has been described by Cohn, a European naturalist. The plant is spoken of by the author of this paper as a seaweed: he supposed it did not occur in this country elsewhere than in Minnesota, and it is not frequent in Europe.

Last year Mr. Arthur visited the locality of the occurrence, and he repeated his visit this summer; but in each instance too late in the season to examine the scum *in situ*. It appears to be composed of innumerable small round bulbs of a transparent gelatinous substance, which are filled with a dark-green material. After they first begin to be seen on the water, the bulbs increase in number with marvellous rapidity. In about two weeks they begin to decay, and their entire disappearance quickly ensues. These phenomena take place usually in June. As no actual experiments have been made upon animals, the deadly qualities ascribed to the so-called seaweed are as yet a matter of conjecture, though the reported facts tend strongly to strengthen the belief that the plant is poisonous.

Relations of certain forms of algae to disagreeable tastes and odors.

BY W. G. FARLOW OF CAMBRIDGE, MASS.

Although large masses of any decaying vegetation may render water unfit for drinking, the only group of plants to be feared, as far as their effect on the taste and odor is concerned, is the members of the nostoc family, which form floating scums of a bluish-green color. When exposed to a bright sun, especially in shallow water, they are transformed into fetid, repulsive-looking masses of slime, which give to the water the so-called pig-pen odor. The water-supplies of several eastern cities have been thus contaminated, and principally by species of Coelosphaerium, Clathrocystis, and Anabaena. In Minnesota is the representative of a fourth genus, Rivularia, which was first found last year at Waterville by Professor Arthur, and which has been found to be very abundant this year in Lake Minnetonka; and in all probability it occurs in most of the other lakes of this region. The singular fact is, that while unknown elsewhere in this country, the species was found several years ago by Cohn in Silesia, who named it Rivularia fluitans; and it was detected also by Gobi near the Gulf of Riga. It appears also to be very closely related to, if not identical with, an alga abundant in certain parts of England, referred by Harvey and more recently by Philips to Echinella articulata, Ag. This is another illustration of the very wide distribution of the species of the nostoc family, of which we have other recent illustrations in the Nostochopsis lobatus of Wood, first described from the northern states, but which has since been found to be identical with Mazea Rivulariaides subsequently discovered in Brazil, and with Hormactis Quoyi found only at Falmouth, Mass., and the Marianne islands in the Pacific.

There is a strong probability, that in the future Minneapolis may be troubled by the decay of the different nostocs floating in the lakes near the city, where they are very abundant. As far as avoiding trouble from these plants is concerned, undoubtedly river-water is to be preferred to lake-water; but before many years the Mississippi near Minneapolis will be contaminated by sewage, and the water will probably then be obtained from the lakes. If the shallower lakes near the city are used, there can be little doubt that in summer Minneapolis will have the same trouble as that experienced in Boston. Even at greater expense, the water should be brought from large and deep lakes, especially those across which the winds sweep so as to keep the surface-water roughened.

The spread of epidemic diseases in plants.

BY W. G. FARLOW OF CAMBRIDGE, MASS.

In the case of animals it can be said, that, excepting the diseases attributed to bacteria, they are subject to but few diseases caused by fungi. In the case of plants, however, the greater part of the diseases to which they are subject are caused by parasitic fungi; excepting, of course, the injuries caused by insects, which need hardly be considered in speaking of epidemic diseases. Most of the violent epidemic diseases of plants are caused by fungi of the orders Uredineae, rusts, and Peronosporeae, rots. Fortunately the species of these orders attack only a single species of host, or at most several species closely related botanically; so that, for instance, a rot which would attack the potato would not probably attack the grape, although it might be expected to attack the tomato, which is botanically closely allied to the potato. As might be expected, the most violent epidemics occur during, or just after, unusually wet periods. An epidemic disease spreads either by the dispersion of its spores through the air, or by the transportation of the host-plant on which it is growing; the latter being probably the means by which diseases are carried across large bodies of water, as the Atlantic.

With the introduction of food-plants from Europe to this country come, of course, many of their parasitic diseases. It should be noted, however, that the most violent plant-epidemics of recent times have advanced not from east to west, but from west to east. The best-known case is that of the potato-rot in 1845, and since then the very accurately recorded case of the grape-mildew, Peronospora viticola, has arisen. In the first case, the disease is supposed to have reached Europe from the west coast of South America, by way of the United States. In the latter case, the grape-mould, which is a native of North America, can, as I showed by experiments in 1876, be transferred to the European vine; and it was prophesied that the disease would extend to Europe, and do more harm than with us. The prophesy was very soon fulfilled, as you all know. In the two diseases just mentioned, it is a characteristic of the spores, that in germinating, instead of giving off a filament, they discharge a number of motile zoöspores, each of which is capable of propagating the disease. We have several other species of Peronospora, which produce zoöspores, some of which have apparently crossed from America to Europe; and there are others which, although common in this country, have not yet appeared in Europe, although, following the grape-mould, they may be expected to appear there hereafter. Among these may be mentioned Peronospora Halstedii, which grows on composites, and may later be found in Europe on the Jerusalem artichoke. Professor Trelease has recently found a Peronospora on Sicyos in Wisconsin, which resembles the grape-mould in general appearance. The germination of the spores has not yet been observed, but judging by analogy one would expect them to produce zoöspores. It would not be surprising if the Peronospora on Sicyos should also be found hereafter causing a disease of squashes or melons; and its progress eastward might be expected as in the cases previously cited.

The speaker then referred to a modification of the spores sometimes observed in Peronospora. Mr. Earle of Cobden, Ill., collected species on Geranium and Viola, where, instead of the usual branching spore-stalks, the spores were borne on the mycelium close to the breathing-pores; the spores themselves being very much larger than in the common form. A similar monstrosity has been noted by Cornu in the grape-mould. The specimens were collected by Mr. Earle in April, and the speaker suggested that this form of spores might perhaps be an adaptation to the cold and wet weather of spring. The conditions which produce the monstrous forms are worth considering by collectors.

Of the diseases caused by Uredineae which have advanced from west to east, the hollyhock-disease, Puccinia malvacearum, is the best-known instance. Its original home was probably Chili; but it spread through Europe about ten years ago, not, however, by way of this country, as was probably the case with the potato-rot. The diseases produced by fungi of other orders, as Ascomycetes, do not spread with the same rapidity as the rusts and rots. This is shown by the black knot, which is so destructive in this country to plums and some kinds of cherries. It is a native of this country, and is found on most of our wild species of Prunus, especially the choke-cherry, a shrub which has been introduced into many places in Europe. As yet, however, the black knot has not made its appearance in Europe.

The speaker then said that he had just found the grape-mildew growing on the Virginia creeper (Ampelopsis quinquefolia) near Minneapolis. As this plant is closely related to the vine, the occurrence of the mildew might have been expected. In attempting to prevent the spread of the disease to countries where it is now unknown, the discovery is of importance. It is evident, that, to prevent the spread of the disease, the importation of Ampelopsis as well as of grape-vines must be prohibited.

Parallelism of structure of maize and sorghum kernels.

BY E. L. STURTEVANT OF GENEVA, N.Y.

If kernels of flint, pop, sweet, and Tuscarora maize be split parallel to the germ, each race will be seen to present a definite arrangement of structure. Thus, the flint corn presents a germ surrounded by starchy matter, and this in turn by a corneous envelope; in the pop-corn proper, the germ is enclosed in the corneous matter, the starchy matter being absent except as the pop variety intrenches upon the flints; the sweet corn has a similar structure to the pop, but the corneous matter is translucent and wrinkled.

By means of blackboard diagrams, the relative arrangements were exhibited of the 'chit' or germ, the corneous matter, and the starch, in the kernels of the above-named varieties of maize and in sorghum.

These different arrangements are constant, and do not pass into each other. The proportion of these elements is also, in general, constant throughout the development of the kernels. The parallelism which is apparent may be accounted for on the familiar axiom that similar forces acting under like circumstances produce similar results.

Agricultural botany.

BY E. L. STURTEVANT OF GENEVA, N.Y.

If kitchen-garden plants be closely studied, in many varieties it will be found that selection has differentiated the various natural species in accordance with desired uses. It will be noticed, that, while there is a striking uniformity within varieties in those portions of the plant which have not been selected for improvement, there is a great variation between those portions which have secured attention on account of their uses. Thus, in forty-five varieties of onions growing side by side, the foliage is all similar; yet the bulbs vary in size, color, shape, and habit of formation. The effect of selection concentrated upon visible forms has been to produce and fix changes from the natural plant to such an extent as in cases to mask the original plant, so that historical data must supplement morphological data in order to connect the genetic record. It is clearly evident, that conscious selection is a powerful agency for the changing of form, and by long exercise can overcome the type affixed by nature to a species. In the domesticated plant, the power of intelligence to eliminate, modify, and direct the action of natural laws under a given purpose introduced a new factor to influence plant-growth; and forms designed for uses mask genetic resemblances in those portions of the plant where change means value to man. If these views are correctly stated, then it is seen that an agricultural botany, as an annex to natural botany, is imperatively required for the purpose of furthering classification of domesticated plants; and such an annex must vary in its methods as widely from the methods of the natural botany as cultivated plants vary from feral plants, the key to the motive being in one case the use, while in the other it is the floral organs.

The present condition of the box huckleberry, Vaccinium brachycerum, in Perry county, Pennsylvania.

BY E. W. CLAYPOLE OF NEW BLOOMFIELD, PENN.

This was an interesting account of a plant that may become extinct. The discovery of this plant took place over hundred years ago, in Virginia, and it subsequently disappeared until 1846, when it was again discovered by Prof. Spencer F. Baird in Pennsylvania. This peculiar plant exists in Perry county, Penn., and in New Castle county, Md., and in no other known locality in the world. It exists in limited quantities there. Its geographical limits are sharply defined, and never extend, but rather recede, indicating a probability of its extinction.

Relation of root and leaf areas; corn.

BY D. P. PENHALLOW OF MONTREAL, CAN.

In the absence of the author of the paper, the secretary of the section briefly stated the contents. The paper sets forth the importance of the relations between the aërial and subterranean surfaces of plants, especially in respect to area. The experiments of the author were mainly upon the growth and development of maize, of which he has tabulated careful measurements showing the proportions of areas above and beneath the soil.

Influence of position on seed.

BY E. L. STURTEVANT OF GENEVA, N.Y.

The 'position' referred to in the title of this paper is that of the individual seeds grown on a spike. The object of experiment was to ascertain the differences of germinating force between seeds from the middle and from the ends of the spike. In trials carried forward at the New-York agricultural experiment-station last winter, it was found, that, for an average of 91 per cent of butt kernels, 88 per cent of central kernels, and 98 per cent of tip kernels, of flint corn, germinated. Other experiments gave the following results: In the butts planted, 79 per cent germinated; of the centres, 84 per cent germinated; and of the tips, 86 per cent germinated. For flint-corn, the tip-kernels have the stronger vegetative power.

Periodicity of Sabbacia angularis.

BY MARY E. MURTFELDT OF ST. LOUIS, MO.

The attention of the authoress was first drawn to this plant in Missouri. It is a matter of popular belief there, that the plant flowers only once in seven years. Mindful of the story in the Greek Reader, of the *scholasticus* who bought a turtle to ascertain whether it would live a hundred years, Miss Murtfeldt obtained some seed of the Sabbacia, and planted it at once. Seven years have expired since the planting, and now the plant is for the first time in flower. In a brief discussion on this paper, Professor Mason showed reasons for doubting in general the popular notions about periodicity in the flowering of certain plants.

An abnormal orchid, Habenaria hyperborea.

BY W. R. DUDLEY OF ITHACA, N.Y.

The peculiarities of this orchid, as observed by the author of this paper, consist of the spur characteristic of its generic relations, the smaller size of the plant, the narrowness of the side petals, and the broad spatula-form of the lips of the flower. These changes are apparently in a direction from an irregular to a regular form of flower. The peculiar cases observed, of which mounted specimens were exhibited to the section, may be due to arrested development; but, the author suggested, they possibly indicate a tendency to revert to older and simpler forms. The habitat of this orchid is not invariably in swamps, but also in dry beech-woods, where they are found to bloom much later than in damp regions.

In the discussion of the paper, Prof. E. D. Cope inquired as to the likelihood of a reversion to a variety of non-spurred orchids, an idea which met with a favorable response from the author.

Origin of the flora of the central New-York lake region.

BY W. R. DUDLEY OF ITHACA, N.Y.

The region referred to contains a series of lakes, and is bounded on the west by the Genesee river and on the east by Oneida lake. It is of a low, sandy character, the shores of the lakes having but a slight elevation; but towards the north the country gradually rises to a level of 2,000 feet above the sea. The whole region may be regarded as a series of old eroded valleys, filled with drift deposits, and having occasional lake-basins; its entire characteristics being such as would naturally give rise to a peculiar flora.

Professor Dudley described seven species among a large and varied flora peculiarly localized in this lake-country, the natural or ordinary habitat of which is variously situated to the south-west, west, and north-west. The conclusion he sought to establish was that the waters of the great lakes had formerly flowed through these valleys, and carried with them these several varieties of a widely scattered flora.

The remarks which followed the reading of the essay favored this theory, and pointed especially to the abrupt eastern limit of the species in question.

Development of a dandelion flower.

BY J. M. COULTER OF CRAWFORDSVILLE, IND.

By means of crayon illustrations, the author of this paper displayed the changes which the different parts of a dandelion-flower undergo in the process of growth to full maturity. The main object was to demonstrate the place, and method of origin, of the ovule.

(*ZOÖLOGICAL PAPERS.*)

Mya arenaria: its changes in pliocene and prehistoric times.

BY E. S. MORSE OF SALEM, MASS.

At a previous meeting of the association, the author showed that the species of shells found in the Indian shell-heaps along the coast of New England differed in their proportionate diameters from the same species living to-day. He pointed out, moreover, that species belonging to similar genera, in the shell-heaps of Japan, had changed in precisely similar ways. It was important to find out, if possible, the cause of these changes. A comparison between the shells of two common species, found north and south of Cape Cod, gave indications that temperature was the inducing cause. The two species selected were Mya arenaria and Venus mercenaria; the former extremely variable, the latter very constant, in its characters. Specimens of these species had been collected in great numbers, both recent and ancient. The following are the indices, of Mya arenaria: —

Recent.		Ancient.	
South of Cape Cod, 61.42.	North of Cape Cod, 61.67.	South of Cape Cod, 62.	North of Cape Cod, 62.78.

of Venus mercenaria: —

Recent.		Ancient.	
South of Cape Cod, 81.01.	North of Cape Cod, 81.10.	South of Cape Cod, 81.51.	North of Cape Cod, 81.81.

Since the waters south of Cape Cod are much warmer than those north of Cape Cod, it was reasonable to suppose that these changes were due to temperature, and that the higher index of the ancient specimens found in the Indian deposits might indicate a colder climate. This supposition receives some support in the fact that a measurement of specimens found in the glacial clays about Portland, Me., and on the Kennebec river in the same state, gave the high index of 66, and a number of Norwich and Red Crag fossils of Mya, which he had the opportunity of measuring at the British museum, had an index of 64; recent Mya from South End, Eng., having the low index of 58.30.

It was interesting to observe, that measurements of Mya in Japan gave, for the southern form, an index of 61.10, and, of a more northern form, 62.50.

In the discussion which followed, Mr. Morse stated that he had made similar observations with regard to other shell-fish.

Some recent discoveries in reference to Phylloxera.

BY C. V. RILEY OF WASHINGTON, D.C.

Every new fact in the life-history of the insects of this genus has an exceptional interest, because of its bearing on the destructive grape-vine Phylloxera. The genus is most largely represented in this country by a number of gall-making species on our different hickories, and the full annual life-cycle of none of them has hitherto been traced. The galls are produced, for the most part, in early spring; the winged females issue therefrom in early summer; and thenceforth, for the remainder of the year, the whereabouts of the insect has been a mystery. The author has for several years endeavored to solve this mystery and at last the stem-mother (the founder of the gall), the winged agamic females (issue of the stem-mother), the eggs (of two sizes) from these winged females, the sexed individuals from these eggs, and the single impregnated egg from the true female, have been traced in several species. There is some evidence, though not yet absolutely conclusive, that this impregnated egg hatches exceptionally the same season; also, of a summer root-inhabiting life. In Phylloxera spinosa, which forms a large roseate somewhat spinose gall on Carya alba, and which has been most closely studied, the impregnated egg is laid in all sorts of crevices upon the twigs and bark and in the old galls, in which last case they fall to the ground.

Up to this time they have remained unhatched, and will in all probability not hatch till next spring, thus corresponding to the 'winter egg' of the grape Phylloxera.

Psephenus Lecontei; the external anatomy of the larva.

BY D. S. KELLICOTT OF BUFFALO, N.Y.

THE species referred to is found in large numbers at the rapids above the falls of Niagara, and is scattered throughout the north-eastern part of North America. The author proposed to supplement the accounts given of it by earlier observers with a record of his own observations, which differed in some respects from those of Dr. LeConte. Several details of anatomical structure were brought to the attention of the members, and illustrated with wood-cuts prepared for the purpose and with specimens mounted in balsam for observation under the microscope.

The Psyllidae of the United States.

BY C. V. RILEY OF WASHINGTON, D.C.

THE Psyllidae, or flea-lice, are rather small homopterous insects, that have remarkable jumping powers. Some of them injure cultivated plants. This is notably true of the Psylla pyri, which blights the buds of pear-trees; and Phyllopleeta tripunctata, which crumples the tips of the blackberry. The family has received little attention in the United States, and scarcely any thing has been known of the life-history and development of the species. The paper enumerates 17 described species, four of these being synonymes, and one of them (Psylla pyri) introduced from Europe. They fall into four subfamilies, and represent four genera already characterized, and three new genera, — Brachylivia, Pachypsylla, and Phyllopleeta. The new species characterized are Calophya vitreipennis, from Arizona; C. nigripennis, on Rhus copallina; C. flavida, on Rhus glabra; Pachypsylla celtidis-cucurbita, forming galls on Celtis texana; P. c.-pubescens, P. c.-asteriscus, P. c.-umbilicus, and P. c.-vesiculum — all forming galls on leaves of Celtis occidentalis; Blastophysa (nov. gen.) c.-gemma, forming galls on the twigs of the same tree; Ceropsylla (nov. gen.) xyderoxyli, a remarkable form developing in pits on the leaves of Xyderoxylon masticodendron; Trioza sanguinosa, on Pinus australis; T. sonchi, on Sonchus arvensis; and Rhinopsylla Schwarzii, from the cypress-swamps of Florida. The paper records discoveries as to the entomography of the species, and especially those affecting Rhus and Celtis; the latter forming a group peculiar to North America, and the most perfect gall-makers in the family.

The most interesting portion of Professor Riley's paper, to those who are not entomologists, was that where he dwelt on the life-histories and habits of the insects he described. The eggs are attached to leaves by a pedicel, and are somewhat pointed at one end, and often terminate in a filament. The young are broad and flattened, with a fringed margin. They are generally pale, and more or less covered with a flocculent secretion. Those on sumach are dark, and without such flocculence. Those making galls on hackberry have stout spines at the end of the body, by the aid of which they are able to work out of their galls.

Note on Phytoptidae.

BY HERBERT OSBORN OF AMES, IO.

THE Phytoptidae comprise a group of very minute mites, species of which produce galls of various forms on the leaves or twigs of various trees. Recent investigation in Europe has placed the group in a different light from that in which it previously was considered. Their study is rendered difficult by their extreme minuteness, and the care necessary to discover the different stages. One of the most common species produces the little wart-like swellings which occur so abundantly on soft maple leaves. A species on ash leaves produces a swelling which is nearly uniform on the upper and under surfaces of the leaf; while another species on the same tree produces a leafy growth at the end of the twigs, the growth sometimes being inhabited also by cecidomyian larvae. On the elm occurs a large deformed leafy growth, which also contains Phytopti: while still another form of gall occurs on box elder, consisting of a depression on the under surface of the leaf, this depression being filled with a woolly growth, and containing Phytopti.

Notes on the potato-beetle and the Hessian fly for 1883.

BY E. W. CLAYPOLE OF NEW BLOOMFIELD, PENN.

THE author found that only one brood of the potato-beetle appeared last year. This seemed an unusual fact, but no second brood had appeared on the potatoes under his observation. In the present year, no beetles appeared during the early stage of the growth of the plant. This fact had been also noticed in New York and New Jersey. He attributed the cessation in the early part of this year to the same unknown cause which had checked the late brood of last year, and asked the opinions of members in determining the cause. Professor Riley thought the disappearance of the beetle could be attributed to the drought. But Professor Claypole said that in 1881, which was an unusually hot and dry season, the beetles were more numerous than he had ever seen them, and gave him more trouble than ever before or since.

In regard to the Hessian fly, Professor Claypole was of opinion that the insect injured the later wheat much more than the early crop, because the crops that gain full strength are best able to resist the attack. Wheat sown before Sept. 10 escaped the ravages of the fly. The winter wheat being chiefly attacked, the observations on the insect had been directed especially to that crop. Contrary to the opinion of many farmers, Professor Claypole believes there are two broods, one in the autumn, and one in the spring. The insect, it is thought, often killed the stalk in the fall, and then probably died with it.

Professor Riley thought that this class of observations could apply only to certain localities, and that in the southern states the conditions might be entirely changed. Professor Forbes thought there were three distinct broods per year in Illinois. As late as July he had found eggs of a brood already abroad.

The structure of the skull in Diclonius mirabilis, a Laramie dinosaurian.

BY E. D. COPE OF PHILADELPHIA, PENN.

A BLACKBOARD sketch of this dinosaur, as reconstructed by Professor Cope, attracted much attention. The animal existed in the mesozoic age, and is estimated to have been 38 feet long. The skull, which is about four feet in length, is in profile a good deal like that of a goose, but, seen from above, is somewhat like that of a spoonbill. Skulls of this type of reptiles are rarely found, and this one throws much light on the question of the classification of the order. The arrangement of the teeth is very peculiar; and the number is very great, amounting to nearly 2,000. The general form of the animal is that of a gigantic kangaroo. The food evidently consisted of very soft aquatic vegetation.

The trituberculate type of superior molar, and the origin of the quadrituberculate.

BY E. D. COPE OF PHILADELPHIA, PENN.

IN the lower eocene, Professor Cope finds all the mammalian molar-teeth to be trituberculate. He has now a complete series of molar-teeth from different mammals in successive horizons, showing all the steps of transition from trituberculate molars of somewhat triangular form and very simple structure, up to the regular quadrituberculate tooth, which is defined as of nearly square section and having four tubercles. Man has quadrituberculate molars: all the monkeys are similarly equipped. Some of the lemurs have trituberculate teeth. Among lower types, such as marsupials and hedgehogs, about half have the tri- and half the quadri-tuberculate development. The insectivora are similarly divided, about half having the old eocene molars and half the modern form. The various steps of development were illustrated by blackboard-drawings.

Two primitive types of Ungulata.

BY E. D. COPE OF PHILADELPHIA, PENN.

THE author announced the discovery of a new mammalian fauna of the eocene, having the following characteristics: 1°. All the fingers and toes are retained; they are plantigrade, each limb having five digital extremities. 2°. The limbs are shorter than usual. 3°. They invariably have a flat astragalus. To the second specification there is one exception, a swimming animal whose hind-limbs were long. One of the discoveries is of a hoof-type animal with carnivorous jaws. It existed in the eocene, and appears to have been of short duration.

In the discussion on this paper, Dr. Dawson stated that some of the plants he had traced in the eocene were well adapted, by the circumstances under which they grew, for supplying food to the creatures described. Professor Cope received this announcement with expressions of pleasure. Thus the new mammal of the old eocene not only bridged the interval between ungulates and carnivores, but also the wider gulf between Dr. Dawson and Professor Cope.

Pharyngeal respiration in the soft-shelled turtle, Aspidonectes spinifer.

BY S. H. GAGE OF ITHACA, N.Y.

DURING the last twenty-five years, respiration in the Chelonia has been investigated with considerable thoroughness, both in this country and in Europe; and at present the chelonian form of respiration is considered to be comparable with that of the mammal, rather than with that of the frog as formerly supposed. While, however, the mechanism of respiration has been very fully investigated, there has been, so far as the author is aware, but one investigator who has considered the organs of respiration in the different groups of turtles. The author showed reasons for believing that a true aquatic respiration, and a true aërial respiration, co-existed in the soft-shelled turtle. It is hoped, that, during the coming year, investigations may be completed which shall determine the exact proportion of the pharyngeal respiration, and the structure of this unusual respiratory organ.

The application of nitrous oxide and air to produce anaesthesia; with clinics on animals in an experimental air-chamber.

BY E. P. HOWLAND OF WASHINGTON, D.C.

THE paper opened with the conclusion of the author that a mixture of nitrous oxide and oxygen, administered in a closed air-chamber, would eventually take the place of ether and chloroform as an anaesthetic for all surgical operations. As ordinarily administered, nitrous oxide cannot be used for prolonged operations, because the blood does not separate oxygen from the gas. Nitrous oxide is expelled from the lungs without change: if it is supplied to them without air or oxygen, death ensues from asphyxia. The author claimed to have administered nitrous oxide for dental and surgical operations in over 30,000 cases. He has found that where unmixed nitrous oxide is used, in the average of cases insensibility is produced in fifty seconds, and recovery from unconsciousness takes place in two minutes. With animals experimented upon, in the average of cases, death ensued within two and a half minutes, where air or oxygen was excluded.

If, at the ordinary pressure of the atmosphere, enough air is mixed with nitrous oxide to support respiration, the mixture fails in producing anaesthesia. But the increase of pressure which can be effected by administration in an air-tight chamber changes the result materially. In such a chamber, with suitable air-pressure, equal parts of air and nitrous oxide breathed from a gas-bag, or a mixture of 85 parts oxide and 15 parts oxygen, can be breathed for an indefinite time without danger or injury, producing perfect anaesthesia while thoroughly oxygenating the blood. The effect of the pressure of air in the chamber is simply to concentrate the mixture in the gas-bag into smaller space; and, when thus concentrated, the oxide does the work of producing insensibility, while the air or oxygen of the mixture keeps up the vital processes.

The author gave an historical account of the discovery of this method of administration by Paul Bert in 1878, and its subsequent applications. Having used it for many capital operations, Dr. Howland recommends the system unhesitatingly. Some points of its excellence, in addition to those already mentioned, were stated as follows: By augmenting or diminishing the pressure, the degree of anaesthesia may be regulated at will, and with mathematical precision. Therefore there is no danger of any of the accidents incurred through the use of ether or chloroform. When inhalation of nitrous oxide and oxygen is stopped, the patient recovers consciousness in a few seconds, and feels no subsequent discomfort. The action of compressed air on the surgeon and his assistants is not injurious.

After the reading of the paper, the operation of the system was exhibited. The air-chamber in this case was a tight box with glass sides; and the patient was a chicken. Perfect anaesthesia was produced and proved; and then, after the chicken was restored to consciousness, it was again placed in the chamber, and killed by the administration of unmixed nitrous oxide.

Conscious automatism.

BY C. P. HART OF WYOMING, O.

THE author confined his inquiry to the manifestation of conscious automatism in man. The question was whether the centres in the cortex of the brain were essential to the production of automatic functions of this character. Claiming that the destruction of these cortical centres induces complete and permanent motor paralysis, the author drew the conclusion that conscious automatism depends upon the integrity of that portion of the brain in which arise consciousness and volition.

Prof. E. D. Cope, discussing the paper, hinted that the author had raised the question upon mistaken grounds; that conscious automatism, of necessity, originated in the cortical portion of the brain, but by the influences of use and heredity became so far habitual that it is independent of volitional impulses. The question is evidently not one of automatical origination, but of functional independence.

List of other papers.

The following additional papers were read in this section, some of them by title only: A fact bearing upon the evolution of the genus Cypripedium, by *E. S. Bastin;* Leaves of the Gramineae with closed sheaths, by *W. J. Beal;* Observations on Cephalopoda, by *Alpheus Hyatt;* Position of the Compositae in the natural system, by *Joseph F. James.*

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

National museum.

Priestley's apparatus. — Priestley's chemical and physical apparatus, now in the possession of his descendants in Northumberland, Penn., has been presented by the latter to the National museum, and will be placed in the collection illustrating the history of science.

STATE INSTITUTIONS.

Iowa weather service, Iowa city.

Weather bulletin for July. — The weather of July, 1883, was very favorable to the crops, being fair, nearly normal in temperature, with an excess of rainfall, and southerly winds prevailing.

The mean temperature of the air was but a little over one degree below normal: last year July was nearly five degrees below normal. The number of hot days has been high, especially during the first and last decade, while the middle decade was cool.

Insolation has been high, because, even during the stormy period, cloudy days were rare, and during the month clear days were numerous. The sun thermometer exceeded 140° on twenty-one days; its highest reading was 161°, on the 23d.

The total rainfall was below normal in southern-central Iowa, from Union to Jasper counties: in the balance of the state it was considerably above normal, averaging about six inches in the north-west and in the south-east, and nine inches in the north-east. The highest rainfall, of fourteen inches, for the month, was measured at Decorah. The number of rainy days averaged ten for the east and north-west, and about six for the balance of the state.

As usual during July, very heavy rains have occurred, but only in the north. The highest rainfall measured on one day was nearly six inches, at Homedale, south of Sibley, in Osceola county, on the 23d; next to this stands Algona, Kossuth county, with over five inches on the same date. But the most notable rain period of the month occurred in north-eastern Iowa, from the 20th to the 23d inclusive, giving very nearly ten inches of rain in Howard and Winnesheik counties.

No tornadoes have occurred, but several squalls have visited parts of Iowa; yet the most destructive of these storms have but touched Iowa. The squall of the 4th started about 5 P.M. in central Iowa, and reached south-eastern Iowa about 9 P.M.: it was not very severe. The squall of the 12th started about 6 P.M. in Black Hawk county, reached the Mississippi in Scott and Clinton counties about 9 P.M., doing much damage by wind and hail: it continued to spread over central Illinois till about 11 P.M. About noon on the 13th another very severe squall started from south-western Iowa, where considerable damage was done in Fremont and Page counties: the storm increased in fury while spreading over north-western Missouri till about 3 P.M. Another storm of less severity visited north-eastern Missouri and southern Illinois on the evening of the same day. A severe squall with hail reached, on the afternoon of the 18th, into north-western Iowa, coming from Dakota. A southerly squall reached Polk and Jasper counties early on the 16th.

On the whole, the weather during July has been very fine: bright skies, aglow with ripening sunshine, alternated with enriching rains, — summed up in splendid crops of small grain and hay, and excellent pastures, and giving promise of a good crop of corn, for the fall season promises well also.

State university of Kansas, Lawrence.

Weather report for July. — In four of the past fifteen years, the July mean temperature has been lower than in this year; but the July rainfall has been but once exceeded during that period (in 1871).

Mean temperature, 76.18°, which is 2.17° below the July average. The highest temperature was 96.5°, on the 23d; the lowest was 56°, on the 9th: giving a monthly range of 40.5°. The mercury reached or exceeded 90° on seventeen days. Mean temperature at 7 A.M., 71.27°; at 2 P.M., 85.71°; at 9 P.M., 73.90°.

Rainfall, 7.23 inches, which is 2.94 inches above the July average. Rain fell in measurable quantities on nine days. There were five thunder-showers. The rain of the 30th yielded 3.10 inches. The entire rainfall of the seven months of 1883, now completed, has been 29.03 inches, which is 7.99 inches above the average for the corresponding period of the preceding fifteen years, and is 1.43 inches above the total rainfall of the year 1882.

Mean cloudiness, 39.46% of the sky, the month being 1.89% cloudier than the average. Number of clear days (less than one-third cloudy), 18; half-clear (from one to two thirds cloudy), 7; cloudy (more than two-thirds), 6. There were three entirely clear days, and three entirely cloudy. Mean cloudiness at 7 A.M., 38.39%; at 2 P.M., 45.48%; at 9 P.M., 34.52%.

Wind: S.W., 39 times; N.E., 15 times; N W., 12 times; N., 9 times; S., 7 times; W., 5 times; S.E., 5 times; E., once. The entire distance travelled by the wind was 10,901 miles, which is 2,229 miles above the July average. This gives a mean daily velocity of 351.64 miles, and a mean hourly velocity of 14.65 miles. The highest velocity was 40 miles an hour, from 1.30 to 2 A.M. on the 12th.

Mean height of barometer, 29.086 inches; at 7 A.M., 29.111 inches; at 2 P.M., 29.071 inches; at 9 P.M., 29.078 inches; maximum, 29.381 inches, on the 18th; minimum, 28.679 inches, on the 11th; monthly range, 0.702 inch.

Relative humidity: mean for the month, 71.4; at 7 A.M., 80.3; at 2 P.M., 54.7; at 9 P.M., 79.1; greatest, 97, on the 31st; least, 20, on the 2d. There was no fog.

NOTES AND NEWS.

Circumstances were not favorable to the production of remarkable essays at the recent meeting of the American association. The attendance was not large. The officers of the meeting, and especially those who had to make addresses, could scarcely be expected to produce elaborate papers in addition to their other labors. As the number of addresses per meeting has increased, we may observe more readily some of the effects of the system that demands them. The most evident result is, that usually, where we gain one good address, we lose two or three good papers.

The distance of the meeting from their homes affected especially members of sections A, B, C, and D, devoted to the exact sciences. Perhaps it affected the quality as well as the number of their papers. There were not many from the east to present essays, though quite as many as could have reasonably been expected; but there were scarcely any from the locality of the meeting and its neighborhood. Local interest, both as to authors and hearers, was of course deficient. In short, there was nothing remarkable in those sections to spur production, and the product was not remarkable. It was good, but not great.

Some of the papers seem to have lost their way among the sections; a paper that was chiefly botanical having gone before the chemists, and the paleontological papers being divided between biology and geology. In some cases the affinities of authors rather than of subjects may have been consulted, though probably the discrepancy was mostly created in efforts to equalize the amount of work in the different sections.

During the progress of the meeting, it being found that botanists were present in unusual numbers, a botanical club was formed. The immediate object was the organization of botanical excursions. An ultimate object is to arrange for preparing a petition to memorialize congress respecting differences between the rulings of the post-office department as to the sending of plants by mail at home and abroad. The organization of the club was somewhat informal. Prof. W. J. Beal of Lansing, Mich., was appointed president, and John M. Coulter of Crawfordsville, Ind., secretary. The roll was signed by twenty-five botanists who were present at the first session of the club, and their number was increased before the meeting of the association adjourned.

We have before alluded to the singular want of executive ability, or of co-ordination in achieving results, which marred the work of the local committee. That continued throughout the meeting, with many embarrassing results. We again refer to it, not to find fault anew, but to mention that the committeemen themselves acknowledged their blunders most heartily in their farewell speeches, and that their kind intentions were manifest throughout.

— Students of meteorology will be interested in a paper lately read by M. Faye before the French academy of sciences on the whirlwinds of sand observed by Col. Prejevalsky in central Asia. M. Faye believes that such sand-storms, like those of Mexico, India, and the Sahara, have the same origin and mechanical action as the tornadoes of the United States and all water-spouts. They are vertical spiral movements, moving horizontally and nearly in a straight line.

— The operations of France in the region of Annam have naturally excited great interest in the geography and ethnography, statistics and commerce, of Annam. A crowd of publications of all sorts are constantly appearing. References of the briefest sort to some of the more notable may be of interest to those who ignore the political side of the question. J. Gaultier publishes for Mallard-Cressin a chart of the region on the scale of 1: 850,000. This is stated to be on the largest scale of any of the maps of this region, and as perfect as the state of knowledge will admit. Another map by Henri Mager, though smaller, is very carefully executed, and includes a plan of the fortress of Hanoi. The oriental studies of the author have enabled him to unify and correct the nomenclature in a satisfactory manner. Romanet du Caillaud has published a long memoir on the protectorate of France over Annam, and the relations between the latter state and China, in the quarterly bulletin of the Société de géographie.

— The enterprise of Johns Hopkins university is shown by the publication of one of its circulars in midsummer, filled with scientific notes in mathematics, physics, biology, and philology. They are all abstracts of papers read before the different active associations in the university, and in most cases will probably be published in full elsewhere. The circular also reprints, from the Royal society's proceedings, the abstract of Dr. Martin's Croonian lecture; and, from the London *Times*, an account of the eclipse observations of May 6, to which Dr. Hastings appends a brief note, pointing out one mistake made by the writer. A list of mathematical models belonging to the university, and of works in the Assyrian and other oriental languages found in the Peabody institute, are also given.

— The following appointments to fellowships in science in Johns Hopkins university are published: In mathematics, G. Bissing and E. W. Davis of Baltimore, and A. L. Daniels of Kendallville, Ind.; in physics, Gustav A. Liebig, jun., of Baltimore, and Charles A. Perkins of Ware, Mass.; in chemistry, D T. Day of Baltimore, J. R. Duggan of Macon, Ga., and E. H. Keiser of Allentown, Penn.; in biology, W. H. Howell and L. T. Stevens of Baltimore.

— Müller's record of the literature of pollination and dissemination for 1880–81 has recently appeared in Just's *Jahresbericht*, containing abstracts of one hundred and forty-nine papers, with many useful items, both critical and supplementary, by the able reviewer. Though these records are very useful when they reach us, their value would be much increased if it were possible to present them to the public more promptly after their preparation. As it is, they are usually two or three years in appearing.

— *Nature* states that the Dutch government have decided not to grant the sum of thirty thousand guilders, which Baron Nordenskiöld claims as the discoverer of the north-east passage. The decision is founded on the motive which led the States-general, in 1596, to offer this award; viz., to find a passage of *commercial* value to the nation. Baron Nordenskiöld having, however, discovered what may be termed a purely *scientific* one, the award, it is argued, has not been earned. As several reasons have been advanced for this claim made by the gallant Swedish explorer, we do not think we err, says *Nature*, when we assert that it was his intention to have expended the sum in the interest of science; viz., on an expedition to the arctic regions.

— George Mantoux has just edited a volume containing the letters and journals of La Pérouse, on his celebrated and unfortunate voyage around the world; preceded by a memoir of that officer, who was last heard from at Botany Bay, and, with his entire party, was wrecked on one of the South Sea Islands, where the survivors were murdered by the natives. It forms one of the *Bibliothèque d'aventures et de voyages* issued by Dreyfous of Paris.

— A Yokohama paper states that Mr. John Milne, whose researches on earthquakes, as explained by him to the British association at Southampton, have excited great interest in scientific circles, and who has since returned to his duties in Japan, has applied to the Japanese authorities to establish an observatory, in order that he may be able to thoroughly investigate underground phenomena. He has sent the authorities a long treatise upon the earthquakes of Japan.

— The *London daily news* says that the Darwin memorial fund has risen to £3,300. Among the most interesting of the sums that the treasurer has received is a cheque for £91.4, collected in Finland.

— The next number of the *Journal* of the Cincinnati society of natural history will contain an illustrated paper by Professor Mickleborough, upon a specimen found by Mr. D. A. McCord of Oxford, O., which has been creating much interest among the paleontologists of Cincinnati and vicinity. It is a small slab of limestone showing on one side the shell of an Asaphus, and on the other the legs of the animal. Fortunately, the rock was split in such a way as to show both the legs and their cast. The characters of the ambulatory appendages of the trilobite are finely shown, and confirm in a remarkable manner the discoveries of Mr. Walcott, who several years since established beyond a doubt the existence of legs in specimens of Calymene.

— The bodies of Professor Palmer, and his companions Capt. Gill and Lieut. Carrington, assassinated by the Bedouin, have been discovered by Capt. Warren, and transported to England, where it is anticipated they will find a resting-place in St. Paul's cathedral.

— Mr. Charles Depérais read a paper before *l'Institute royal d'encouragement de Naples*, April 5, in which he advocated the embalming of bodies by boiling them in a solution of chloride of calcium, and then in a solution of sulphate of soda.

— The government of Ontario has published for the Entomological society of that province a general index to the thirteen annual reports upon injurious insects which the society has made to the commissioner of agriculture. The index is prepared by William Baynes-Reed, and consists of a serial and a classified list of illustrations, and a general index to the text. It appears to be prepared and printed carefully.

—The death of the famous M'tesa, King of Uganda and baiter of missionaries, is announced.

—The following papers were prepared during the past year by members of the Lawrence scientific school, Harvard university, under the supervision of Dr. E. L. Mark in the embryological laboratory at the Museum of comparative zoölogy:—

On the development of Oecanthus, and its parasite Teleas, by Howard Ayers of Fort Smith, Ark.; on the development of the posterior fissure of the spinal cord, and the reduction of the central canal, in the pig, by William Barnes of Decatur, Ill.; notes on the development of Phryganidae, by William Patten of Watertown, Mass.; the relation of the external meatus, tympanum, and eustachian tube, to the first visceral cleft, by Albert H. Tuttle of Dorchester, Mass.

The papers by Mr. Ayers and Mr. Patten have been awarded respectively the first and one of the second Walker prizes by the Boston society of natural history, as already stated in these columns. All are to be published in the course of a few weeks.

—The eighth annual report of the Buffalo microscopical club shows a membership of forty-six,—a gain of fifteen during the year. The average attendance at the monthly meetings is stated to have been about twenty-five,—certainly a very large percentage.

—Prof. D. P. Penhallow, having resigned his connection with the experiment department of Houghton farm as botanist and chemist, has accepted the lectureship of botany at McGill university.

—Messrs. Allen, Coues, and Brewster sign a call for a convention of American ornithologists, to be held in New-York City, beginning on Sept. 26, 1883, for the purpose of founding an American ornithologists' union, upon a basis similar to that of the 'British ornithologists' union.' The object of the union will be the promotion of social and scientific intercourse between American ornithologists, and their co-operation in whatever may tend to the advancement of ornithology in North America. A special object, which it is expected will at once engage the attention of the union, will be the revision of the current lists of North-American birds, to the end of adopting a uniform system of classification and nomenclature, based on the views of a majority of the union, and carrying the authority of the union.

It is proposed to hold meetings at least annually, at such times and places as may be hereafter determined, for the reading of papers, and the discussion of such matters as may be brought before the union. Those who attend the first meeting will be considered *ipso facto* founders. Active and corresponding members may be elected in due course after organization of the union, under such rules as may be established for increase of membership. Details of organization will be considered at the first meeting.

—'The books of science' is the title of a work announced by Leypoldt as in preparation by William C. Lane of Harvard college library. It is to be an annotated catalogue of the most trustworthy works for the study chiefly of the physical and mathematical sciences. From what we know of the compiler and of the manuscript, a portion of which we have examined, we may confidently predict a very useful work.

—In his address before the American forestry congress last year at Cincinnati, recently printed in the *American journal of forestry*, Prof. F. L. Harvey gives a catalogue of the forest-trees of Arkansas, of which he enumerates a hundred and twenty-nine indigenous species. According to his summary, Arkansas is remarkable for its extensive belts of pine, for the area of hard-wood growth, and for the number of species usually classed as shrubs, which here attain the dimensions of trees. More than half the species belong to the six orders Magnoliaceae, Rosaceae, Urticaceae, Oleaceae, Juglandaceae, and Cupuliferae. Professor Harvey believes that physical conditions, rather than geological horizon, affect the specific character of the vegetation in Arkansas, where the north-western part of the state is upland and paleozoic, and the remainder lowland and of more recent date.

RECENT BOOKS AND PAMPHLETS.

Paluzie, F. La historia natural explicada á los niños, según las clasificaciones de Couvier. Madrid, *Perdiguero*, 1883. 160 p. 8°.

Registro general de la industria española, con una sección extrangera, en que figuran las fábricas y establecimientos industriales más importantes de los diversos países de Europa y América, y agenda del industrial, continuación del Almanaque publicado desde 1875, por la *Gaceta industrial.* Año primero (1881–82). Madrid, *Tello*, 1882. 238 p. 4°.

Ritsema Bos, J. Insektenschade op bouwen Weiland. Handleiding voor de kennis vsn de kleine vijanden van akker-en weidebouw. Groningen, 1883. 216 p. 8°.

Roiti, A. Elementi di fisica. Firenze, 1883. 12+356 p. 16°.

Roura, J. Tratado sobre los vinos, su destilación y aceites. Madrid, *Perdiguero*, 1883. 113 p. 8°.

Sack, J. Die verkehrs-telegraphie der gegenwart. Wien, 1883 (Elektro-techn. bibl., v.). 272 p., illustr. 8°.

Sieiro y González, J. Principios de psicología ó anthropologia psiquica, lógica y ética. (Orense), *impr. Ramos*, 1882. 319 p. 8°.

Smith, Ch. Conic sections. London, 1883. 8°.

Smith, J. M. The Hades of Ardenne, a visit to the caves of Han. Described and illustrated by the T. T. Club. London, 1883. illustr. 8°.

Sonklar v. Innstaedten, C. Von den ueberschwemmungen, enthaltend die ueberschwemmungen im allgemeinen, chronik der ueberschwemmungen und mittel der abwehr. Wien, 1883. 151 p. 8°.

Sundman, G., and **Reuter, O. M.** The fishes of Finland (and Sweden). pt. i. Helsingfors, 1883. 9 p., 3 col. pl. f°. Will contain about 30 parts.

Tobler, A. Die elektrischen uhren und die feuerwehr-telegraphie. Wien, 1883 (Elektro-techn. bibl., xiii.). 240 p., illustr. 8°.

Ungarn, Geologische special karte von. Herausgegeben von der k. ungarischer geologischen reichsanstalt. Budapest, 1883.

Walras, L. Théorie mathématique de la richesse sociale. Leipzig, 1883. 256 p., 6 pl. 8°.

Wittstein, G. C. Handwörterbuch der pharmakognosie des pflanzenreichs. Breslau, 1883. 994 p. gr. 8°.

Zacharias, J. Die elektrischen leitungen und ihre anlage. Wien, 1883. (Elektro-techn. bibl., xvi.) 272 p., illustr. 8°.

SCIENCE.

FRIDAY, SEPTEMBER 14, 1883.

THE U. S. SIGNAL-SERVICE.

I.

The annual report of the chief signal-officer for 1881, recently issued, is a volume which ought to be of great interest to all concerned in the progress of meteorological science in this country; and it would be, were it not for certain characteristics too apt to be found in government publications. Of these, the most notable at first sight is its ponderous bulk. After one has received the polite notice, 'a package too large for the carrier,' etc., and has achieved its safe delivery in one way or another, he is likely to wonder what end it may be best made to serve. If he be interested in meteorology, he will find it well worth his while to give at least one volume of the series a careful examination, in order that he may know what not to read in the next.

In its thirteen hundred broad pages, together with its maps, charts, etc., he will find much that is valuable; much that, to him, is perfectly useless; and, if his tastes be not too circumscribed, much that is amusing. A government report is not a likely place in which to seek entertainment; but, considered as a scientific publication, the report will furnish its share. In this respect it is, doubtless, clear ahead of all other scientific documents issued by the government.

As a scientific document it must be considered; for, since the organization of the weather bureau of the signal-service, by far the larger part of the operations of that service have had to do with meteorology; in fact, the work in the way of practical meteorology constitutes the only *raison d'être* of the service as at present organized and equipped.

A fair examination of this work can only be made by a comparison of this report with those of the several preceding years: indeed, justice could not be done the present administration without such a comparison, as it indicates changes of considerable moment, which seem likely to greatly increase the efficiency and value of the service.

The first part of the volume consists of the report proper of the chief signal-officer. This seems, in each case, to be made up almost entirely by copying from the report of the previous year. It must have been written, of course, at some time, and by somebody; but when and by whom will soon be lost to the history of meteorological science. A few additions are made, fewer subtractions, and now and then a linguistic blunder has been eradicated, after it has done faithful service for several years. The impression is everywhere conveyed, that the preparation of this, which one might expect to find the freshest and most readable portion of the volume, is annually committed to the skill of a copying-clerk. It is not to be denied, that certain statements in regard to the service will bear, and deserve, repetition; and, indeed, the chief signal-officer himself inserted a sort of an apology for this repetition a few years ago, which has been faithfully reprinted along with the rest ever since. But whole pages are repeated year after year, when it would appear that they had served their purpose in a single publication; and this seems all the more uncalled-for in the case of much which might better have never been published at all.

We are annually informed, that "meagre reports only have been received of the instruction for the field duties of the signal-service elsewhere than at Fort Myer;" and we wonder why whoever is responsible for this neglect is not urged to remedy it, through some other avenue than the annual report. The need of a fire-engine at the post was a standing item for several years; but, as it does not appear in the last report, it may be assumed that the want has been supplied, possibly through the generosity of some distressed reader.

The space occupied by the fire-engine is now filled, however, by the extraordinary and interesting announcement, that "the post-garden is in good condition, and has, for some time, been a source of supply to the company mess." The importance of this statement entirely overshadows that of many others which might be quoted, — such as that the enlisted men have succeeded in managing the coal-oil lamps which have been supplied them, that the buildings of the post will require painting the coming season, etc.

In some instances the annual reprint has not received that attention which might be expected even from clerical supervision. One of the statements which has regularly made its appearance for several years is this: "It is needless, with such facts in view, and after —— years of continuous service, to reiterate the advantages secured to the signal service by its military organization." In spite of this declaration, the reiteration has been religiously kept up; and it was evidently intended that the above blank should be properly filled as the years rolled by. In the report for 1879, it is filled with the word 'nineteen,' and this is exactly copied in that for 1880. In the report for 1881, the word 'twenty' is substituted; so that, unless an effort is made to 'catch up' in the next report, the corps will be deprived of one 'year of continuous service,' and the argument will be proportionately weakened.

Illustrations of useless and careless reprinting might be continued to almost any extent; but it will be of greater interest to pass to Appendix I., which contains the courses of instruction furnished at Fort Myer for the training of officers and men belonging to the service.

If this is to be considered as a school for the education of meteorological observers, its curriculum is certainly marvellous. Although certain portions of the course of study are given in the report in great detail, — even to the paragraph and page at which each lesson begins and ends, other portions are not so well defined; and some assumptions must be made as to the time occupied in certain parts of the work. It is thought that no injustice is done in the following estimate of the distribution of study and practice: —

Officers who are assigned to the school for instruction in the duties of the service remain there about one year. The instruction is theoretical and practical. In the theoretical course, about 37 per cent of the whole time is spent in the study of meteorology and meteorological observations. In the practical course, 8 per cent is a high estimate for the time devoted to that subject. Indeed, out of the year's work, it is prescribed that *eight days* shall be spent in the meteorological observatory; in which time the officer is expected to learn "the use of all instruments used at observation offices of the signal-service, care of and repair of same, and making out of meteorological forms." The remainder of the year is devoted to the study and practice of military signalling, wand-practice, military surveying, electric telegraph, international signals, etc. It is fair to add, however, that for officers who are assigned to the headquarters of the chief signal-officer, and are candidates for service in the 'indication-room,' a very liberal course of advanced study and reading in meteorology is prescribed to be carried on at the office of the weather-bureau accompanied by practice in the preparation of charts and in 'forecasting.'

The enlisted men, however, upon whom falls the burden of collecting the great mass of meteorological material, which is daily digested in the central office, do not fare so well. The period of their stay at Fort Myer is limited to about six months, during the first two of which they cannot be placed under class instruction, but are required to recite in cavalry tactics, to attend wand and telegraph practice, to stand guard, and attend to other military duties. When, at last, they are permitted to begin the study of meteorology, the percentage of their time given to it is not noticeably greater than that of the officers. During their six months at the fort, ten days are spent in the meteorological observatory; and in that time they are expected to learn, and probably do learn, all that the officers acquire in the eight days which is allowed them for practice in meteorology. When it is remembered that the sole occupation of the great majority of these men, during the entire period of their enlistment after leaving Fort Myer, is to make and record meteorological observations, it seems little short of folly to subject them to such a course of training in preparation. That only ten days, out of the one hundred and eighty spent in the school, should be occupied in practical training in observation, and the use of instruments, is certainly an inversion of the true order of things. It is difficult to see the value, to such men, of the long training in 'cavalry tactics,' the 'manual of the carbine,' the 'manual of the kit,'—whatever that may be, —and many other things found in the course. It is true, that, to observers stationed on the seacoast, a knowledge of naval signals is necessary; and, to all, a degree of familiarity with the practical working of the electric telegraph would be desirable: but the business of the great majority of the observers is purely scientific, and, it is to be hoped, peaceful in its character. It is clear that the skill and knowledge necessary to the successful performance of these duties must be largely acquired after active service has begun.

The chief signal-officer very properly remarks, that the criticism to which the service has been subjected is evidence of its success. No well-informed person can fail to feel great pride in the results achieved by the signal-service since the organization of the weather-bureau. The general increase in the accuracy of its forecasts, the efforts made to communicate important meteorological information to localities likely to be seriously affected by probable changes in the weather, and its valuable services in the display of cautionary and danger signals, have given it a hold upon the confidence of the people not easily weakened.

The percentages of verification of predictions since the organization of the weather-service, as given in the various reports, are as follows:

Year.	Per cent of verification.	Year.	Per cent of verification.
1871	69	1877	86
1872	77	1878	84
1873	77	1879	86
1874	84	1880	86
1875	87	1881	85
1876	–		

In the display of cautionary and danger signals, the success has been about equally great. In forecasting, in which the character of the weather only is considered, the percentage of verification is generally as high as ninety.

While these figures do not indicate any marked progress during the past five years, it must be remembered that a point has been reached from which farther advance must necessarily be difficult and slow.

'REX MAGNUS.'

AT the suggestion of the editors of SCIENCE, I have carefully examined the 'viandine' brand of the new preservative 'Rex magnus,' and find it contains boracic acid, sodium, potassium, and water as ingredients; and I believe its composition can be roughly formulated as follows:—

Boracic acid } Borax }	67 per cent.
Potassic chloride	15 "
Water	18 "

The mixture also contains very small amounts of sulphur and magnesium. Both, however, are probably accidental impurities.

To determine the preservative properties of the viandine brand, a number of experiments were undertaken, the general result of which can best be shown by copying some of the notes taken during the course of the experiments, and supplementing them with a formulated table.

July 5, I dissolved one-half pound of viandine in one gallon of water contained in a stone jar, and placed one pound of beef-steak, one pound of veal-steak, and one pound of fresh mackerel in the solution.

July 6, the beef, veal, and fish, which had remained in the solution twenty-six hours, were removed, and, after allowing them to drain for two or three minutes, were placed on plates in the laboratory.

July 7, I boiled the solution which had been used with the meats and fish, and removed the scum that rose to the surface. When cold, I added about two ounces of viandine, and poured the solution into a stone jar containing one pound of mutton-chops and one pound of liver.

Tabular statement of experiments with 'Rex magnus.'

July.	Temperature.	Beef-steak.	Veal.	Mackerel.	Liver.	Mutton-chops.	Roasting piece of beef.	Leg of mutton.
5	86°	Placed in solution.	Placed in solution.	Placed in solution.	– –	– –	– –	– –
6	85	Taken from solution.	Taken from solution.	Taken from solution.	– –	– –	– –	– –
7	84	No odor.	No odor.	No odor.	Placed in solution.	Placed in solution.	– –	– –
8	73	No odor.	No odor.	No odor.	Taken from solution.	Taken from solution.	– –	– –
9	70	No odor.	No odor.	No odor.	No odor.	No odor.	– –	– –
10	72	No odor.	No odor.	No odor.	No odor.	No odor.	– –	– –
11	71	No odor.	No odor.	No odor.	No odor.	No odor.	– –	– –
12	79	No odor.	No odor.	No odor.	No odor.	No odor.	– –	– –
13	78	No odor.	Slight odor.	No odor.	No odor.	No odor.	– –	– –
14	79	No odor.	Slight odor.	No odor.	Leathery look, slight odor.	No odor.	– –	– –
15	79	No odor.	Slight odor.	No odor.	Slight odor.	No odor.	– –	– –
16	77	No odor.	Odor.	No odor.	Slight odor.	No odor.	– –	– –
17	80	Eat a piece, palatable.	Odor.	No odor.	Odor.	No odor.	– –	– –
18	79	No odor.	Odor.	No odor.	Odor.	No odor.	Placed in solution.	Placed in solution.
19	73	No odor.	Odor.	No odor.	Odor.	No odor.	– –	– –
20	74	No odor.	Odor.	No odor.	Odor.	No odor.	Taken from solution.	Taken from solution.
21	76	No odor.	Very disagreeable.	No odor.	Thrown away.	No odor.	No odor.	No odor.
22	79	No odor.	Strong odor.	No odor.	– –	No odor.	No odor.	No odor.
23	75	No odor.	Strong odor.	No odor.	– –	No odor.	No odor.	No odor.
24	77	No odor.	Thrown away.	No odor.	– –	No odor.	No odor.	No odor.
25	76	Slight odor.	– –	No odor.	– –	Slight odor.	No odor.	No odor.
26	79	Tasted a piece, not palatable.	– –	No odor.	– –	Tasted a piece, not palatable.	Slight odor.	Slight odor.
27	77	– –	– –	No odor.	– –	– –	Cooked, did not dare to taste, odor very strong.	Odor stronger.
28	75	– –	– –	Eat a piece, palatable.	– –	– –	– –	Cooked, odor so strong I could not remain in the room.

Note.—The temperature is the mean of three daily observations taken at about nine o'clock A.M. and three and ten P.M. The laboratory in which the meats were placed was well ventilated, and protected from flies and insects by wire screens. One pound of the viandine used was obtained from the office of Science, the rest by express from the Boston office of the company.

July 8, I took the mutton and liver out of the solution, allowed them to drain, and placed them on plates in the laboratory.

July 13, the plate in which the liver had been placed was nearly full of a red-colored liquid, and the liver had a hard leathery appearance. The liver and veal had both acquired a slight odor. The other meats and fish smelled sweet.

July 16, the odor of the liver and veal had become stronger than on July 13. The liver was placed on a clean plate, as the first plate was full of the red-colored liquid. The beef, mutton, and fish still looked and smelled fresh.

July 17, I had one-half of the beef-steak which had been treated with the viandine solution on July 5 cooked for breakfast. It was tender and palatable: still, it was not like a fresh steak. There was a slight taste of borax; and there was also a want of flavor, something like what fresh beef-steak might have if it were washed with cold water before cooking. Poured a little viandine solution over the veal and liver.

July 18, a roasting piece of sirloin beef, weighing five pounds, also a leg of mutton weighing four and one-half pounds, — being first punctured in a number of places, especially in the neighborhood of the bones, with an iron skewer, — were placed in two gallons of the viandine solution made up like the solution of July 5. The liquid was in a stone jar, and completely covered the meats.

July 20, the beef and mutton, which had remained in the viandine solution thirty-six hours, were removed, allowed to drain for two minutes, and placed on plates in the laboratory.

July 21, I was obliged to throw away the liver, the odor being very offensive. The veal had a disagreeable odor. A few mould-spots were removed, which had appeared on the steak. No odor, however, was perceptible. The mutton-chops and fish also smelled fresh. Placed steak and mutton in viandine solution for one half-hour.

July 24, it became necessary to throw away the veal. Beef-steak, mutton-chops, mackerel, roasting piece of beef, and leg of mutton appeared fresh.

July 25, the beef-steak and mutton-chops smelled slightly old.

July 26, I had the remaining half of the beef-steak which had been treated on July 5, and the mutton-chops which had been treated on July 7, cooked for dinner. No odor was noticeable; but they had a very high taste, so much so as to be unpalatable, save to a starving man. The roasting piece of beef and the leg of mutton smelled slightly. The mackerel appeared and smelled fresh.

July 27, the mackerel, which had remained in the laboratory since July 5, was cooked for breakfast. It was fresh and fairly good, like mackerel that are served at the average hotel table. There was no taste of borax. The roasting piece of beef was to be served for dinner. On cooking, a very offensive odor was given off. An examination showed a small piece near the bone that had become decayed. The rest of the beef appeared good; but pieces cut from different parts all had a strong odor of putrefaction. The mutton in the laboratory had a perceptible odor.

July 28, the mutton was cooked for dinner; but, when placed on the table, the odor was so strong that I could not remain in the room.

The results obtained from the above experiments seem to show, that pieces of meat having large surfaces in comparison to their thickness, as steaks and chops, and also small fish, can be kept a considerable length of time, although with some deterioration in taste, by the use of the viandine brand of Rex magnus. In the case of larger pieces, such as a roasting piece of beef, or leg of mutton, having tried only two experiments, I do not care at this time to speak positively. I can, however, state, that I should have some hesitation in again allowing to be cooked in the house large pieces of beef and mutton that had been kept in a warm room for ten days after treatment with the solution of viandine.

LEONARD P. KINNICUTT.

Worcester free institute, July 28, 1883.

THE IGLOO OF THE INNUIT.[1] — V.

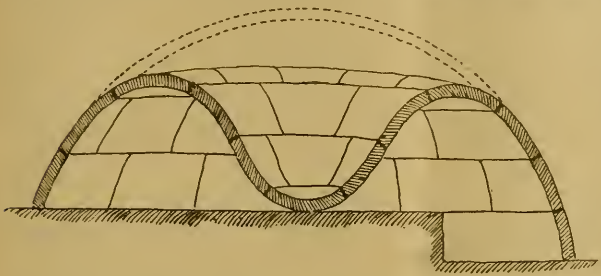
As the spring wears on, and thawing weather comes, the igloo falls into a decline; and when an exposed place can be found to pitch the seal-skin tent, it is abandoned. Before this can be found, however, the igloo assumes a new combination phase, which must be described. When several igloos have fallen in and buried their contents (the women, babies, and puppies managing to wriggle out, and a good share of the things being lost in the *débris* of snow-banks), the Innuit ceases to build any thing more than the walls of snow, using the prospective tent for a roof; this being the same as the autumn igloo, excepting the body, which is of snow, and not of ice. This phase of the igloo is so well shown in the illustration on the next page, taken from the German book of a member of my party, Mr. Klutschak, entitled '*Als Eskimo unter den Eskimos*,' that I transfer it to this article. His sketch of our spring igloos was taken on Cape Herschel, King William's Land, on the 16th of June, 1879, — the day before we abandoned them for the summer, and moved into tents.

The tenacity of some igloos, however, before they tumble in, is truly wonderful. They always give ample warning by slowly sinking on the top and side towards the sun or warm wind; and this the inhabitants counteract by thrusting a pole from the inside through the dome at its most threatening point, and there firmly lashing several small cross-pieces to prevent further sinking, which it will do if not too warm, or some small dog with bone in mouth, and pursued by a larger, does not take refuge on top, as is their wont, — when the snow-dome, dogs and all, come tumbling in on the heads of the hyperboreans. The foot of this pole rests on the floor, hardened by tramping, or a board is put under it to give it support. I have, however, seen a high-domed, abandoned

[1] Concluded from No. 31.

LIEUT. SCHWATKA'S PARTY, ENCAMPED IN SPRING IGLOOS, IN KING WILLIAM'S LAND, JUNE 16, 1879.

igloo, which had been well chinked and lightly banked (the whole mass nearly homogeneous from long use), slowly subside from the top until this touched the floor, and so remain without tumbling in, the igloo being actually inverted in its upper half or two-thirds. Here

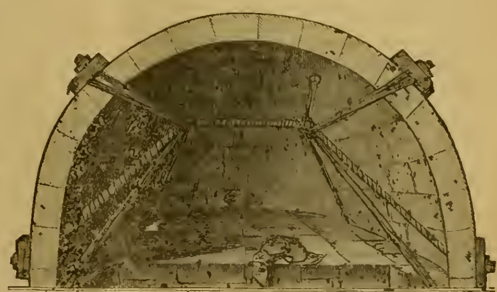


it would remain for a few days before warm weather would cause it to fall to pieces. I have tried to show a cross-section through such an igloo, the broken line showing its original position.

When food is readily procured without much effort, as in seasons of great plenty, the natives do not wholly abandon the necessary exercise to keep them in good muscle and bodily health, as is the general opinion respecting these people, but have been known to keep it up by various gymnastic devices, one of which (tight-ropes made of thongs of walrus-hide neatly and strongly lashed within an empty igloo) is well portrayed by Capt. Hall in the illustration.

I should like to give a few brief descriptions of those appurtenances that might be strictly called igloo accessories, as the native stone lamp and kettle, the well to fresh water through the thick ice, beside the snow-hut and many other minor items all growing out of the igloo itself; but this article has already grown to such dimensions that they must be laid aside.

The utility of the igloo cannot be exaggerated. Habituated as my little party of white men were, during our two winters in these desolate zones, to a constant life in these simple habitations, and the many comforts accruing therefrom, I have often marvelled how white men could stand the hardships and privations of a spring tent-life in the many expeditions wherein they were used, and under circumstances that would have been absolute pleasure to my party. I have read so often of their sufferings while journeying in tents, and the discomforts and even dangers they risked while living in ships and other unsuitable arctic abodes, during short journeys from these places, under such intensely low temperatures as −50°, −60°, or even −70° F., when under almost the same conditions my party was prosecuting a comfortable sledge-journey four hundred to five hundred miles from its base of supplies, with no provisions except such game as was killed from day to day, that the conviction becomes two-edged that the accessories of igloos, and their constant companion of the cold, the reindeer clothing, are absolutely essential to a well-managed arctic sledge-journey. With their help, strange as it may seem, the subject of temperature becomes entirely of secondary importance, if it enters the arctic travelling problem at all; and, were it not for the long dark night which accompanies these thermometrical depressions, I



INNUIT TIGHT-ROPES.

believe that a protracted sledge-journey could be carried successfully forward in the continuous cold of the lowest recorded temperature, all other things being favorable.

Frederick Schwatka,
Lieut. U. S. Army.

A UNIVERSAL LANGUAGE AND ITS VEHICLE,—A UNIVERSAL ALPHABET.

SHALL the world ever see an end of the confusion of tongues? Shall differences of language cease? Or shall, at least, some selected medium of thought be established throughout the world, by which all men may understand each other on occasion, while still preserving their vernaculars for intercourse at home? A consideration of the subject may enable us to answer these questions.

Language in all its varieties is a growth; and every living language is still growing, shedding leaves here, and pushing out new leaflets there, according to its vigor of vitality. The most copious language of to-day was smaller yesterday, and smaller still in every generation through which we can trace its history. We cannot go back to its beginning, for it properly had none: it did not spring from a seed, and so take the definite form of a parent language; but each tongue arose from the crossing and interlocking and blending of shoots from older languages, until they grew together, and became a new stem, from which, in turn, shot other branches, to repeat the process to the end of time.

In the comparative study of languages, and in what we know of human history, we can trace the evidences of this continuous cross-grafting of branch on branch in various directions; and the oldest tongues are those to which some peculiar form of growth can be traced back and back through the greatest number of stages.

If we could follow these oldest languages up to their respective sources, we should find at last a very small vocabulary of simple utterances used to denote an extremely limited number of ideas. But we should find no primitive natural germ of speech from which the first language had sprung into life and shape. The faculty of *expression*, and the instinct of *imitation*, are the only primitive parts of language; but these, at first, were, like primitive creation, 'without form, and void,' until consenting minds agreed on some few associations of sound and sense, and so commenced a form of language.

Any number of different forms may have been thus commenced by isolated families or groups of men. Individual members of different families or groups would occasionally come together, and each would enlarge the other's vocabulary, or modify his methods of expression. Thus one may have previously used only a dual number to indicate plurality; another, only an indefinite plural: but mutual intercourse would incorporate, in the common language that would be developed, both of these methods of expressing and defining the idea of plurality. Primitive languages may thus have acquired from each other the many words and forms of speech which they possessed in common; while their independent characteristics would increase in the absence of association.

On the same principle, a closer intercourse between modern nations must have an amalgamating effect on their languages, and so tend to produce an ultimate unification of human speech. This closer intercourse is being accomplished in our days by railroads and steamships; and strange ears in all quarters of the world are being familiarized with the languages of visitors and immigrants. The interests of commerce, and the influence of example and of social feeling, lead to a more and more general acquisition of the languages thus introduced; so that, without displacing local forms of speech, other media of wider intercommunication are being gradually extended everywhere. A universal language *is thus growing up*. Whether it will ultimately take the lines of English, French, German, or some other tongue, will depend on the relative fitness of the competing languages for universality. At all events, the fittest will survive, and the survivor will gradually occupy the whole field.

The present diffusion of English over the continents of America and Australia, and among sailors of all nations; its growing acceptance throughout the continental countries of Europe; its establishment in many nuclei in Asia and Africa, and over the vast empire of India, as well as the grammatical simplicity of the language, and its power of incorporation of foreign elements, — all point to English as the probable universal tongue of the future.

The only alternative to such adoption of the fittest among existing languages would be the creation of a new form of scientific speech; but this would require a universal consent among nations, and a combined effort, that may fairly be considered impossible as preliminaries to the institution of such a language. The creation of a new form of speech adapted for universal use is certainly within the power of science and invention to accomplish; but the aid of a pre-existing language, all but universal, would be required for its introduction and establishment. In the far future, such a form of scientific speech may find the world prepared for it, and the medium for its diffusion in sufficiently general use: but, in the mean time, the confusion of tongues is being gradually reduced by the struggle for supremacy among established languages; and this process will go on until one tongue shall be intelligible, if not predominant, everywhere.

All languages have their physical material in common: they use the same vocal organs, and essentially the same elementary sounds. The voice is susceptible only of a limited number of modifications, and the lips and the tongue only of a limited number of articulative actions; and, from the combinations of these, all the varieties of human utterance result. This elementary simplicity and uniformity are not, however, reflected in the writing of languages. Alphabets are wholly arbitrary; and, although the same letters are used in many alphabets, a different value is, in nearly every case, associated with the individual letters. A universally intelligible method of representing the sounds of speech is a necessary prerequisite for a universal language. Ordinary alphabetic writing is, indeed, as much a hindrance to combined effort for the unification of language as was the confusion of tongues to the building of the tower of Babel. Some method of classifying and representing all known modifications of voice and articulation, if not of discovering all possible modifications, had long been the great desideratum of philologists. Attempts were made to frame a universal alphabet by collating the elements from local alphabets, ancient and modern; but the number of shades of difference discovered among the elementary sounds, and the difficulty of recognizing sounds under varied associations, rendered any complete classification impracticable. So far as the discovery of the entire category of possible sounds was concerned, the object of endeavor was considered to be hopeless; and the attempt to realize it was finally and formally abandoned at a convention of philologists of different countries, held at London in 1854. The declaration of this convention stands on record, that —

"It would be useless and impossible to attempt to find for each possible variety of sound a different graphic sign."

This 'impossibility' has, however, been since accomplished with completeness and simplicity, in the system entitled 'Visible speech,' the principles of which will now be explained. In this system no sound is arbitrarily represented, but each letter is *built up* of symbols which denote the organic positions and actions that produce the sound. The letters are thus physiological pictures, which interpret themselves to those who have learned the meaning of the elementary symbols of which they are composed.

The first letter of our ordinary alphabet, which we call $\bar{a}$, is known in other countries as *ah;* but we discover, in using the letter, that it represents both *a* and *ah*, and a variety of other sounds in our own language, the letter *a* being employed for the six diverse vowels in the words *ale*, *air*, *an*, *agree*, *ah*, and *all*. In Visible speech each of these sounds has a separate letter, and each letter explains to the eye the organic means by which its sound differs from other sounds. For example:

The letter for the vowel in the word *ale* tells the reader to —

Advance the front of the tongue towards the front of the palate, so as to leave a channel of medium breadth for the passage of the voice.

The letter for the vowel in *air* tells him to —

Place the tongue in the same position as before, but to expand the back cavity of the mouth.

The letter for the vowel in *an* tells him to —

Broaden to the utmost degree the channel between the front of the tongue and the palate, and at the same time expand the back cavity of the mouth.

The letter for the sound of *a* in *agree* tells the reader to —

Place the tongue in a neutral position, — neither advanced nor retracted, raised nor depressed, — *and expand the back cavity of the mouth.*

The letter for the sound *ah* tells him to —

Depress the tongue backward as far as possible, and expand the back cavity as before.

The letter for the vowel in *all* tells him to —

Place the tongue in the same position as for AH, *but compress the back cavity, and round the corners of the lips.*

All these directions are perfectly conveyed at a glance in the different letters; and yet the letters, so far from being complex, consist of forms more simple than the letters of the Roman alphabet. Here, for example, are the symbols, — four in number, — from the combinations of which, not merely the sounds above illustrated, but every vowel in every language, can be expressed to the eye, so as to be at once pronounced with exactitude by the reader.

ELEMENTARY SYMBOLS OF VOWELS.

These symbols have the following invariable meanings: —

1. The straight line means *voice*.
2. The bar across the line means contraction or rounding of the *lips*.
3. The solid point means *compression* of the back cavity of the mouth.
4. The open hook means *expansion* of the back cavity of the mouth.

The position of the point or hook on the straight line denotes the position of the tongue in reference to the palate. Thus: —

a. When on the right side, the meaning is, that the tongue is advanced towards the *front* of the palate.

b. When on the left side, that the tongue is retracted towards the *back* of the mouth.

c. When on both sides, that the tongue occupies a *middle* position between front and back.

d. When at the top of the line, that the tongue is *raised* towards the palate.

e. When at the bottom, that the tongue is *depressed*.

f. When at both ends, that the tongue occupies a *middle* position between high and low.

Nothing could be simpler than these elements, the meanings of which are remembered by every person after a single explanation; yet from these four elements alone the entire series of normal vowels, thirty-six in number, are built up. Two diacritic signs extend the possible number of shades of vowel-sound, which these four elements can be made to represent, to the largely superfluous total of one hundred and eighty.

The English alphabet contains only five vowel-letters, while our speech makes use of at least sixteen vowel-sounds, without including diphthongs. No wonder, therefore, that the relation between letters and sounds is one of irreconcilable confusion. A purely phonetic alphabet, in addition to the common system of letters, is a necessity for the intelligible writing of English alone; much more is it indispensable for the writing of all languages intelligibly to all readers.

The system of Visible speech is the ready vehicle for a universal language, when that shall be evolved; but it is also immediately serviceable for the conveyance of the diverse utterances of every existing language. No matter what foreign words may be written in this universal character, they will be pronounced by readers in any country with absolute uniformity. The means have been explained by which *vowels* are represented for this purpose. The principles are now to be shown on which *consonants* are written with the same effect.

Elementary symbols of consonants.

Five elementary symbols furnish letters for all the consonant actions of the lips and tongue. These symbols are —

C ɛ | ʃ ⁏

As with vowels, so with consonants: all the elements of each class have one symbol in common. The vowel-symbol was shown to be a straight line: the consonant-symbol is a *curve;* and the direction in which the curve is turned denotes the part of the mouth by which the consonant is formed. Thus: —

a. The curve turned to the right denotes the *lips*.

b. The curve turned to the left denotes the *back* of the tongue.

c. The curve turned archwise, with its end down, denotes the *top* of the tongue.

d. The curve turned with its end up denotes the *point* of the tongue.

The five radical symbols have the following meanings in every combination: —

1. The first (C) is the sign of a part of the mouth used to form a *consonant*.
2. The second (ɛ) is the sign of a part of the mouth which *divides* the breath.
3. The third (|) is drawn across the ends of a curve to denote a consonant that *stops* the breath.
4. The fourth (ʃ) is the sign of emission of breath through the *nose*.
5. The fifth (⁏) is added to the ends of a curve to denote simultaneous modification by *two* parts of the mouth.

These elements, combined into *six* forms of letters, suffice for the whole series of consonant actions of the lips and tongue. The six forms turned in the four directions, as above, yield twenty-four letters; and the uniform addition of one sign for *voice* — a straight line in the centre of the curves — converts the twenty-four into forty-eight letters.

Every part of every letter has thus a meaning legible at a glance; and the most complex letter in the alphabet — combining four of the elementary symbols to exhibit the sound of *m* — is as simple in form as the common Roman letter for the same consonant. Thus: —

Ɛ M, m.

The following are the four symbols combined in this letter: —

1. A curve to the right, which denotes the *lips*.
2. A centre straight line, which denotes *voice*.

3. A waving line, which denotes *nasal* emission.

4. A line closing the curve, which denotes *stoppage* of the breath.

The letter thus says to the reader: —

Stop the breath by means of the lips, and sound the voice through the nose.

It must be obvious that such directions, conveyed without words, will be uniformly interpreted by readers of any nationality who have simply learned the meaning of the radical symbols. All the Visible-speech letters are formed in this way, by synthesis of two or more out of a total number of nine elements. Such letters, consequently, make up an alphabet adapted for universality, because independent of explanatory language; also because its symbols are physiological pictures, and because the writing, even of unheard foreign tongues, is self-explanatory to the reader's eye.

Visible speech was first published sixteen years ago (August, 1867); and it has been very generally studied by philologists, and adopted in theoretical works as a necessary exponent of linguistic phonetics. It has also been widely utilized in America for the teaching of articulation to the deaf. But its popular uses for the teaching of vernacular languages to children and illiterates, and of foreign languages in schools and colleges, as well as for the literation of hitherto unwritten Indian and other tongues, have not yet been correspondingly developed. People generally do not take the trouble to investigate the nature of the characters, but suffer themselves to be repelled by fancied difficulty, — as if what is strange must needs be difficult. But the difficulty is only to eyes unacquainted with the principles of the symbolization. When these are known, there is no comparison, in point of simplicity, between Roman letters and Visible-speech letters. To children and illiterates, all letters are equally strange. To one who can already read, the eye is simply prejudiced in favor of established letters. In the present exposition the *letters* of Visible speech have not been made the basis of illustration, but only the rudimentary symbols from which all the letters are derived. This mode of treatment will, it is hoped, leave no room for prejudice to act.

In this stage of the world's history we do not need to concern ourselves about a universal language: that will develop itself in due time. But a universal medium for the communication of languages is a practical necessity, which every day renders of more and higher importance. Without a universal alphabet there never could be a universal language; with a universal alphabet the progress of the fittest language towards universality will be enormously accelerated. At present, English seems the most likely to achieve this distinction; but its natural fitness is antagonized by its defective and irregular system of letters. Give English the advantage of an alphabet simple and phonetically perfect, and, whereas it is now the most difficult of all tongues for foreigners to learn, it will become by far the easiest.

In the system of Visible speech a universal alphabet is for the first time attained: the system is of English birth. Let its native language have the benefit of this instrument of diffusion, and the world-wide predominance of the speech of Britain and America will be assured. A. MELVILLE BELL.

LETTERS TO THE EDITOR.

Variations in butterflies.

BETWEEN the 20th of June and the 10th of July, I obtained three hundred and eighty Vanessa Antiopa from caterpillars fed on swamp willow. Twenty-five of these were varieties, and the balance were of the usual form. Two of the varieties were Lintneri, from which all the blue had disappeared. The third had the primaries Lintneri, while the secondaries had the usual blue spots. The fourth had the secondaries Lintneri, while the primaries bore the blue spots. In the remaining twenty-one, the whole upper surface of the wings had a mottled appearance, showing that the colors had been disturbed. They retained the blue spots, but the spots were much smaller than usual.

The veins in the twenty-five varieties remained soft for several days; not becoming firm and hard, like the veins in the others, although treated in the same manner. I have also found this softness of the veins in the varieties of Turnus, where the red is suffused, and in the rust-colored specimens.

All the Vanessa Antiopa which I have seen this season have the yellow of a much deeper shade than I have ever before noticed.

Colias Philodice is also remarkable this season in this respect. S. LOWELL ELLIOT.

New York City, 3d August, 1883.

Function of the colorless blood-corpuscles.

The interesting abstract of Zawarykin's important investigations into the function of the leucocytes in the absorption of fats from the intestinal canal (SCIENCE, ii. 192) calls to mind an investigation by Franz Hofmeister, into the absorption and assimilation of the peptones, which will be of interest in connection with the abstract referred to.

In a series of papers published in 1881, Hofmeister[1] comes to the interesting conclusion, that "absorption of peptones in the intestinal canal is, accordingly, no simple mechanical process of diffusion or filtration, but is rather a function of particular living cells, the colorless blood-corpuscles; and these play, in the nutrition of the organism, a similar rôle to that of the red corpuscles in respiration."

In his discussion he calls attention to the presence

[1] Zeitschr. phys. chem., v. 151,

of the leucocytes, in great numbers, in the adenoid tissue during digestion; and, also, to certain proofs of the ability of the leucocytes to combine with peptones in a loose form of combination.

The similarity of these two functions of the colorless corpuscles, as determined by Hofmeister for peptones, and by Zawarykin for fats, cannot fail to suggest the probability of a very definite and important function of these corpuscles in general nutrition. Possibly, also, the anomalies observed in the absorption of saccharine food, and in the glycogenic functions of liver and muscles, may in time receive some explanation through the functions of the colorless corpuscles.

It seems as if we were, at last, beginning to obtain an idea of the functions performed by these important cells, whose close connection with the life of the organization has been generally recognized, though but vaguely understood. J. M. S.

HUMAN PROPORTION.

Human proportion in art and anthropometry: a lecture delivered at the National museum, Washington, D.C. By ROBERT FLETCHER, M. R. C. S. E. Cambridge, *King*, 1883. 37 p. illustr. 8°.

FROM the earliest ages, man has found his standards of measurement most conveniently in some bodily measure, like the digit, the palm, the span, the foot, or the cubit. As these measures necessarily vary with the size of the individual, the attempt to ascertain their average led to the first systematic measurements of the human body: hence have sprung the innumerable schemes of human proportion devised by artists and anatomists, all founded on the belief that some one part of the body was a standard of measurement for all its other dimensions. The Egyptians first developed a canon of proportion as early as the thirty-fifth century B.C., which was twice subsequently changed. Their last canon adopted the length of the middle finger as the standard, reckoning it precisely one-nineteenth of the entire stature. But in the 'canon of Polykleitos,' the famous sculptor who flourished about 450 B.C., was embodied the highest rule of Greek art in its most flourishing period. This has fortunately been preserved in a well-known passage of Vitruvius, and is illustrated by a recently discovered drawing by Lionardo da Vinci. The restless spirit of modern life has not remained content with this, as more than a hundred different attempts bear witness by men of all nations, including the celebrated English sculptor Gibson and our own Story. All these methods have been based upon the theory that there is a fixed relation between some one portion of the body and all its other dimensions; and their number proves the fallacy of the idea. Anthropometry, on the other hand, measures with the strictest scientific accuracy the living man, and from an immense mass of measurements obtains the mean of the human form, and thus arrives at the perfect human type. The father of this science is the Belgian Quetelet, and the enormous number of measurements rendered necessary by the draft during our civil war have greatly advanced it. By its tests many a time-honored dogma bearing upon human proportion has been exploded. Thus it has been proved that the length of the outstretched arms is somewhat greater than, and not exactly equal to, the height of the body; that not eight, but seven and a half heads make up the entire stature; and that only in the negro skeleton can be found the length of humerus bestowed upon the Apollo Belvedere.

All these matters the author has illustrated with great learning and in a clear and animated style. We have noticed, however, that his knowledge of archeology is sometimes at fault, — as where he calls the '*crux ansata*' in the hand of the Egyptian standard figure 'a key,' which is really a cross with a loop or handle attached to it, and is the symbol of eternity; or suggests that the 'golden fleece' was in reality 'the secret of Egyptian art;' or states that the Doryphoros of Polykleitos was 'a beautiful youth in the act of throwing a spear,' instead of its being one of the 'spear-bearers,' the body-guard of the Persian king. The most marvellous statement, however, is, that "prior to the time of Phidias, the face, hands, feet, or other exposed parts of the body were carved in marble, and fastened to a wooden block, which was covered with real drapery." This is a complete misunderstanding of the nature of the archaic ξόανα, or wooden statues, which in Greece preceded those made of stone or metal.

WARE'S MODERN PERSPECTIVE.

Modern perspective: a treatise upon the principles and practice of plane and cylindrical perspective. By WILLIAM R. WARE, Professor of architecture in the School of mines, Columbia college. Boston, *James R. Osgood & Co.*, 1883. 321 p. 12°.

PROFESSOR WARE's Modern perspective is in substance a series of papers printed two or three years ago in the *American architect*, but with additions which extend its range, and give it more the scope of a scientific treatise. Scientific it is, both in its idea and its methods; though its treatment is naturally freer than would be given it for scientific uses alone, — freer, perhaps, than the author would have given if it had originally been written as a formal treatise. The purely geometrical method comes out most clearly in the chapters added in the revision, particularly in two (xvii., xviii.), in which, after going over the ground of practical perspective, Professor Ware sums up, first the principles and relations, and then the chief problems, in the most abstract and generalized form. This portion is, therefore, scientifically the essence of the book, and is that which a reader versed in pure mathematics, but unacquainted with perspective, might properly read first. Such a reader would find pleasure in its neatness and comprehensiveness of statement, and in the skilful way in which the whole subject is cast in condensed and logical form; every phenomenon or process being first presented in its most general aspect, — against the usual habit of books on perspective, — and particular cases deduced from it afterwards. These chapters make a sort of inner treatise, whose appeal will be to the geometer and the special student. They are probably too abstract and too concise to be acceptable to the ordinary student, and he may be left to skip them.

The methods of the book are naturally those of descriptive geometry. We could wish Professor Ware had held to the received terminology when he names the perspective of the vanishing-line of a plane its 'trace,' and diverts the word from its received sense as the intersection of the plane with the plane of projection. What in descriptive geometry is called the trace, Mr. Ware calls the 'initial line' of the plane: the point where a line pierces the picture-plane, which might by proper analogy be called the *trace* of the line, he calls its 'initial point.' The use of 'horizon' for the actual vanishing-line of any system of planes is happier. The subscript notation employed is the author's own, and is cleverly contrived to suit the manner of his exposition. It contains in itself a symmetrical record of the principal data and relations, and its neatness and efficiency make one the more regret that the author has not cared to follow an accepted terminology where there is one.

The phenomena of planes in perspective are first discussed, according to the author's uniformly analytical method: first oblique planes, then parallel and normal. So much of the perspective phenomena of lines is accounted for by treating them as intersections of planes, that their separate consideration is much shortened by anticipation; and by the time the point is reached, its discussion is reduced to a minimum. In like manner, instead of confining the discussion of points of distance, as is common, to points in the horizon-line, or the prime vertical, the most general case is first considered, and the circular locus of all the points of distance of a given line is determined. We miss the categorical statement, — implied, to be sure, but worth making distinctly, — that the points of distance are the same for all parallel lines; as in another place it is apparently taken to go without saying, that the vanishing-point of a line, or the vanishing-line of a plane, is enough to determine problems relating to its direction, even when its position is unknown. The chapter of abstract problems presents pretty much all the problems of descriptive geometry, so far as concerns planes and right lines, applied in perspective, and therefore covers, except for a few special cases, all the elements of perspective practice. Here, again, generalization and condensation are carried very far: some, indeed, of the problems in which many alternatives are grouped together are perhaps too succinct and comprehensive to be satisfying to the student.

The same method and quality are found in the other chapters of the book, so far as suits with its practical purpose. Thus parallel perspective, usually taken first, is postponed, and treated as a special case. There is throughout a watchful eye to the needs of the architectural draughtsman and the painter. The work is made interesting by observation of natural and pictorial phenomena, many of which are, so far as we know, new to the books. Some special topics which are taken up in the advanced treatises are here hardly mentioned, — the perspective of curved surfaces and of solids of revolution, for instance; even vaulting being left untouched, and the problems not going beyond plane figures and solids with plane faces. But within its limits, the discussion is very complete; and some subjects are enlarged upon which it is usual to dismiss with slight mention, — the perspective of reflections, and of shadows by both parallel and divergent light, and especially the chapters on the perspective of the circle, and on perspective distortions and corrections. The method of the perspective plan is made much of, as it deserves; and some space is given to M. Adhémar's ingenious devices for avoiding remote vanishing-points, and carrying on all the operations on a small sheet by means of what Mr. Ware calls 'small-scale data,' — points of fractional distance, scales of depth, marginal co-ordinates, and the like, — a method which is much less known than it deserves to be. Mr. Ware adds an ingenious alternative for M. Adhémar's device of enlarging the remote parts of the perspective plan by planes of successively steeper inclination.

The plates which accompany the book are as thoughtfully and ingeniously composed as the text. We commend the whole treatise as the most complete, so far as we know, and the most interesting and instructive for practical use, that has been published in this country.

SEEBOHM'S VILLAGE COMMUNITY.

The English village community, examined in its relations to the manorial and tribal systems, and to the common or open field system of husbandry: an essay in economic history. By Frederic Seebohm. London, *Longmans, Green, & Co.*, 1883. 464 p., 13 maps and plates. 8°.

It is now many years since G. L. von Maurer wrote his Introduction to the history of marks and manors. Since then the subject has attracted many students, and has been much looked into and talked about. Many books have been written upon it; those of Nasse, de Laveleye, and Maine being the best known to American readers. The impression conveyed by these writings is, that the mark or village community, though almost always found upon a manor, under manorial overlordship, was in its origin independent. Manorial overlordship arose, we are told, in later times. The village community was drawn under it, and became subject to it. It has been the work of modern times to restore it to its ancient independence. This is the theory of von Maurer and his followers, which we have gathered from their books. Objections to this theory are from time to time raised. It is urged that the village community is usually found under manorial landlordship; that it is, therefore, an open question whether the village community, or the landlordship over it, is the earlier institution. In Mr. Seebohm's book, which now lies before us, it is maintained that landlordship is more ancient than the village community, that the village community arose under landlordship, as a community of slaves or serfs, that it has been slowly emancipated from slavery and from serfdom in the course of centuries. Our economic history, we are told, begins with the serfdom of the masses under manorial landlordship. Looking through the records, back to the earliest period, we find no free village communities, only manors with village communities in villenage upon them. The argument upon this point is almost conclusive. The existence of a manorial system during the Saxon period of our history is established beyond doubt.

But there were parts of Britain which were not manorial, where village communities (the village community being considered a part of the manor) did not exist. What was there in the parts of Britain where there were no manors? By the side of the manorial system was a tribal system more ancient, perhaps, than the manorial system. Then follows an account of the tribal system of the Welsh and Irish, which is extremely interesting. It is not clear at first, why, in a work upon English economic history, so much space should be given to the institutions of the Welsh and Irish; but we find out directly: it is that we may the more clearly understand the statements of Caesar and Tacitus regarding the Germans. It is well known that the statements of Caesar and Tacitus are very vague; that they become intelligible only in the light of extraneous evidence. We ourselves should not have presumed to draw this evidence from the Welsh laws, nor from the Brehon tracts. It has always seemed to us best to keep the records of different peoples quite distinct. We should, therefore, have turned from Caesar and Tacitus to the German folk-laws, formulae, and documents. The tribal system of the Germans is very well described in the German records. It happens, however, that the tribal system of the Germans resembles very closely that of the Welsh and Irish: so, though we do not follow all the steps of Mr. Seebohm's argument, we come, at last, to very nearly the same conclusion. What we have in the time of Caesar and Tacitus, and afterwards in many places where the manorial system has not been developed, are tribal households (to use Mr. Seebohm's phrase), — isolated farmsteads, occupied by groups of descendants and heirs; the land being held by them as an undivided inheritance for two or three generations, and then divided, several households arising where there was but one before. Mr. Seebohm finds a vestige of this system in the custom of Gavelkind in Kent, where we have divisions among male heirs, with traces of the right of the youngest to the original homestead. Almost everywhere else in England the tribal system has quite passed away.

Already, however, in the time of Tacitus, the manorial system was germinating. The free tribesmen who lived in the tribal households here and there — *ut fons ut campus ut nemus placuit* — had slaves who cultivated the land for them. These slaves were distributed by the tribesmen in village communities, in regard to which they were very much in the position of the later manorial lords. It was only a step, indeed, from this condition of things to the manorial system. This step was taken immediately after the permanent settlement of the Germans within the limits of the Roman empire. The land system of the later empire was very much like a manorial system. So it happened, that, while the Germans were approaching this system on the one hand, the Romans were approaching it on the other. They reached it together.

This is the briefest possible *résumé* of Mr. Seebohm's extremely interesting and valuable book. The argument is well arranged and very convincing. It is, perhaps, a little too much encumbered by details; but we should be sorry not to have these details, and the book is quite readable in spite of them. The account of the manorial system is the most complete that we have. The book is a mine of information upon the subject. It will be found indispensable to students. It is very well printed, and illustrated by plates and maps. It would be worth having for these alone. In conclusion, we must heartily congratulate the writer upon the completion of so excellent and useful a work.

STEARNS AND COUES' NEW-ENGLAND BIRD-LIFE.

New-England bird-life; being a manual of New-England ornithology. Revised and edited from the manuscript of Winfrid A. Stearns, by Dr. Elliott Coues. Boston, *Lee & Shepard*, 1881, 1883. 324+409 p. Illustr. 8°.

UNDER this title Mr. Winfrid A. Stearns and Dr. Elliott Coues have just produced an excellent and much-needed work. Previous to its appearance we have had no complete or satisfactory exposition of the subject, despite several attempts on the part of inexperienced or otherwise incompetent authors to cover the interesting field: hence the present book is doubly welcome.

It has appeared in two volumes, or parts. Part i., issued two years ago, begins with Turdidae, or thrushes, and carries the subject through Oscines, ending with the family Corvidae. In addition to the 270 pages occupied by its main portion, there is an 'Introduction' of fifty pages, which includes useful chapters on the classification and structure of birds; the 'Preparation of specimens for study;' the 'Subject of faunal areas;' and the 'Literature of New-England ornithology.' Including those devoted to its special index as well as to the introduction, part i. contains 324 pages.

Part ii. was published early in the present year. It has in all 409 pages, of which ten are occupied by an 'editor's preface,' and eight by the index; the remaining 397 pages treating the general subject from Tyrannidae through the successive families to Alcidae, last and lowest in the scale of New-England bird-life. Both volumes are rather copiously illustrated with fairly good woodcuts; some of which are full-length figures, others representations of the heads, feet, wings, etc., of birds, designed to show technical or distinguishing characters. Most of these cuts have done similar duty before, but on this account they are none the less useful in the present connection.

The plan of the book is so clearly and tersely outlined in the preface to part i., that we cannot do better than give it in the editor's own words: —

"It is the object of the present volume to go carefully over the whole ground, and to present, in concise and convenient form, an epitome of the bird-life of New England. The claims of each species to be considered a member of the New-England fauna are critically examined, and not one is admitted upon insufficient evidence of its occurrence within this area; the design being to give a thoroughly reliable list of the birds, with an account of the leading facts in the life-history of each species. The plan of the work includes brief descriptions of the birds themselves, enabling one to identify any specimen he may have in hand; the local distribution, migration, and relative abundance of every species; together with as much general information respecting their habits as can conveniently be brought within the compass of a hand-book of New-England ornithology."

This plan is consistently and faithfully carried out. The descriptions of the birds, to be sure, are a little meagre and unsatisfactory at times; but it must be remembered that they are intended primarily for a class of amateurs who are not fitted, either by experience or inclination, to wade through more exact, technical diagnoses.

The biographical matter is written in the editor's well-known and eminently characteristic style, — a style not wholly free from faults perhaps, but, in the main, so finished and picturesque that it is sure to attract and interest every lover of birds. In the present instance, the only fault we have to find with these biographies is that they are often too brief and general, — in short, that there is too much condensation. Especially is this the case among water-birds, where the account of habits, distribution, etc., is frequently crowded into a few lines. Doubtless this was necessary to keep the work within its assigned limits, but it is none the less a disappointment.

One of the most valuable features of the book — to the scientific ornithologist, at least — is the bringing together of previous records pertaining to the rarer birds. In almost all cases these have been exhaustively collated, a work chiefly, if not wholly, performed by Mr. Purdie, whose well-known fitness for the task is a practical guaranty of its thorough accomplishment.

The weakest spot in the structure is that of the editor's rulings on questions affecting the comparative abundance and seasonal distribution of the less-known birds. In many — far too many — cases, his conclusions are more or less unwarranted or premature; in not a few, they are positively and demonstrably erroneous. This was to be expected, however, in view of the fact that neither editor nor author is known to have had an extensive experience in New-England fields or woodlands; and, considering such limitations, it is chiefly remarkable that they have done so well.

But, despite its shortcomings, 'New-England bird-life,' as a whole, may be honestly characterized as a work of real merit and unquestioned utility. Its faults are seldom vital, its excellences many and obvious. Although a manual, rather than a comprehensive general treatise, it cannot fail to take a high and permanent place among the literature of North-American ornithology. To the student of New-England birds, it is sure to prove a valuable hand-book, adequate for the determination of most problems which the limited field is likely to furnish. There is still room, of course, for the more extensive structures which some future builders will doubtless rear on this substantial corner-stone.

Before concluding, we find it necessary to revert to a rather delicate subject, — that of the ostensible authorship of the book. In the preface to part i., the editor touches on this, as follows: —

"Mr. Stearns undertook this work several years ago, at the writer's suggestion, that such a treatise was much to be desired, and could not fail to subserve a useful purpose. Having been diligently revised from time to time, in the light of our steadily increasing knowledge, Mr. Stearns's manuscripts have been submitted to the editor's final corrections. In revising, and to some extent rewriting, them for publication, the editor has been influenced by the author's request that he would alter and amend at his own discretion."

Perhaps we are bound to accept this explanation literally; but the reader familiar with Dr. Coues's characteristic style and methods will find few traces of Mr. Stearns's alleged participation. Clearly the 'revising' was very thoroughly done. We might go even farther, and venture the surmise that Dr. Coues not only edited, but *wrote*, the entire book. But is this a matter with which we have any business to meddle? Probably not so far as Dr. Coues's interests are at stake. If he chooses to do all the work, and take less than half the credit, it is his own affair. Nevertheless, it certainly *is* our right to challenge a reputation unfairly won, and until further proofs are forthcoming we shall refuse to believe that Mr. Stearns's agency in 'New-England bird-life' has been much more than nominal. Perhaps the inside history of the book will never be made public, but intelligent ornithologists are likely to see through a millstone with a hole in the middle.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

PROCEEDINGS OF SECTION H. — ANTHROPOLOGY.

ADDRESS OF OTIS T. MASON OF WASHINGTON, D.C., VICE-PRESIDENT OF THE SECTION, AUG. 15, 1883.

THE SCOPE AND VALUE OF ANTHROPOLOGICAL STUDIES.

EVERY thing that comes before the human mind has to pass through a process of weighing and measuring, and receives a valuation according to the thinker's standards of merit. In this critical spirit let us pass in review those studies called anthropological, in order to form some estimate of their value according to the measures commonly applied to various departments of learning.

Anthropology is the application of the instrumentalities and methods of natural history to the inductive study of man. The anthropologist, in this sense, is not a dilettante philosopher, who inquires into old things because they are old, or into curious things while they are curious, omitting all the great movements and needs of society, and overloading the baggage-train of progress with trumpery picked up along the march. The practical spirit of our age demands that we ask what truth, or good, or beauty comes from such investigations, and how we can make them subservient to human weal.

As to the scope of anthropology, we may be instructed by the work of others. The natural history of any species, say of the domestic horse, includes many inquiries, such as the time and place of its origin; its ancestry; its pristine size, appearance, and mode of living. We should afterwards inquire concerning the archeology or the paleontology of the Equidae, their embryology, anatomy, physiology, diseases, abnormalities, and external characteristics. Mr. Romanes would have a chapter on the intelligence of the animal, as to its nature and amount, supplementing the discussion with notes on the various ways in which the horse manifests its mind, its wills, emotions, and opinions. Horses do not construct elaborate houses like the ants and the beavers; but the members of all species occupy their daily lives in some habitual industries by means of which they wear out the excess of muscle. Sir John Lubbock would lead us farther, and show us that horses go in droves, follow a leader, plan migrations, attacks, and defence, amuse themselves, enjoy one another's company, improve in appearance, intelligence, and usefulness by cultivation, — in a thousand ways show themselves to be social creatures. At last Mr. Mivart would insist that the horse has its habitude (ἕξις), its manner of action, its economy (oecology), and its members are affected in a characteristic manner by heat, light, moisture, winds, the kind and quality and abundance of food and drink, by beneficial or injurious animal neighbors, and by the vital, procreative, inheritable energy with which they are endowed. These and many other kindred inquiries concerning this homogeneous group would constitute the science of hippology.

The conscientious devotee to this science would frequently ask himself what practical good would result from all this expenditure of time, thought, and resources necessary to collect specimens and facts, and to formulate his science. Could they be employed on some subject more ennobling and profitable to himself, better calculated to inform, enrich, and beatify mankind?

Now, instead of horses, let us substitute the *genus homo*, laying aside all predilections; and, if possible, let us imagine the student of anthropology to belong to quite another genus than the subject of his research. He would have, in the fourteen hundred millions of human beings now living on the earth, and the remains of their congeners slumbering in its bosom, perhaps the best defined group of animals. Calling them a genus or a species, as you like, they are so well hedged off from all other animal groups that not the least embarrassment has ever disturbed the naturalist in distinguishing the anthropos even from the anthropoid. No one was ever puzzled to tell, concerning any living thing, whether or not it was a human being. The earth has never yielded a bone concerning which the practical anatomist stood in doubt whether it had been once part of a human body.

Now, I take it for granted that any inquiry whatever which would be useful or entertaining respecting another species would be intensified in importance having man for its object. Indeed, there are few questions which naturalists are wont to propose to their groups which ought not to be carefully considered when we are studying man. Before entering upon the weighing process, therefore, it may make our task more easy if we consider the present scope of anthropology, and briefly pass in review some of the questions which are being propounded by anthropologists every day.

When did man first appear on earth, — at what time and in what geological horizon?

Have all the individuals of our race descended from a common human ancestry? in other words, are we monogenists, or polygenists?

Where was the birthplace of humanity?

What manner of creature was that first man in specific characteristics, in size, aspect, intelligence, and social condition? and how did he get here?

To all such queries, Haeckel aptly gives the name of anthropogeny: therefore, in order to be anthropologists we must be anthropogenists.

Another set of questions relates to that stretch of time which lies between the pristine man, or the pristine condition, and the beginnings of recorded history.

Have we complete, irrefragable evidence that our race has progressed from a brute-like condition, in which it was devoid of all experience and appliances?

What application must we make of Professor Tylor's belief that civilization has progressed upward like a column of vapor, some parts advancing while other parts are being rolled downward, but, on the whole, ascending and expanding?

Granting that there has been improvement, what paths have been pursued?

Speaking of our own peculiar province, what is the real import of such discoveries as those of Dr. Abbott and Professor Whitney in establishing the great antiquity and early rudeness of the American savage?

Who were the builders of the mounds, earthworks, cliff-dwellings, and the stone structures of Middle America?

What were the functions of these various edifices?

What credence is to be given to the early historians of American culture?

Already we have our schools of interpretation, such as the Bancroft school and the Morgan school. Where, among these opposing schemes, does the truth lie?

In the administration of this science, there is occupation for the greatest diversity of talent. The biologists of our time are entering into the minutest inspection of the life-history of each animal form. With enthusiasm the embryologists trace the modifications of structure as they succeed one another in the germ. Before their eyes the very play of creation is dimly shadowed, and organic structure built up. They pass their work on to the anatomists and physiologists. Now, the anthropologist must endeavor to comprehend the whole in its synthesis. As Newton and Laplace grasped the unity and organization of the stellar world, as Humboldt gazed upon all created things as elements of the universal cosmos, as Darwin first conceived the consanguinity of all living beings and their mutual help or harm, so the anthropologist seeks to unite all that can be known respecting man into a comprehensive science, and to study the innumerable correlations which bind the most incongruous actions and thoughts together in harmony.

May we gain help, in solving questions of human origin, by carefully observing the evolution of the embryo?

Does a knowledge of the life history of the individual furnish a clew to the life history of the species?

What does a comparison of the anatomy of man with that of the quadrumana say respecting the genealogy of the species?

What are the proper methods and instruments of anthropometry, — observing the growth of children, the dimensions, angles, and curves of the cranium, the diversity and size of the brain according to age and sex and race, the weight of the body, the color of the skin, hair, and eyes, the muscular movements, the development of faculties, longevity, fecundity, plasticity under change of environment, and vigor? and what are the legitimate inferences to be drawn from such investigations?

Finally, by what devices can the multitudinous correlations of structure and function in the human body find expression in graphic methods?

Another set of observers must now be brought into this great laboratory. We have to deal with a group of animals in which intelligence has manifested itself to such a degree as to dominate all other functions. Teleological inquiries can be no longer excluded. Hitherto the application of scientific methods to the mind has required that we should be satisfied with sensuous results of thought, and forbidden us to inquire into the nature of the mind itself. Now, we are met at the outset with this puzzling question: Shall consciousness or introspection be admitted as an instrument of observation?

How are we to record its dicta? and how (to borrow a term from the astronomers) shall we eliminate the personal equation?

Or, if we are not in a position to admit introspection among our tools of observation, can we not invent some delicate apparatus by means of which the strength of feeling and the inmost thoughts may be known and measured?

Does the brain generate thought as the liver generates bile?

What can science tell us concerning the existence of a human soul, non-material, and not susceptible of measurement by the standards of well-known forces?

How does it come about that children inherit the traits, tendencies, and faculties of their progenitors?

By what routes does the mind pass on its way from infancy to maturity?

What use should be made of the multitudes of inquiries prosecuted with reference to the minds of animals, in the study of human reason?

The student of anthropology frequently finds himself in sympathy with Wordsworth, singing, —

> "Our birth is but a sleep and a forgetting;
> The soul that rises with us, our life's star,
> Hath had elsewhere its setting,
> And cometh from afar."

If, as Mr. Spencer says, that which we inherit represents the accumulated experiences of a thousand generations, is it also possible to retain the consciousness of those experiences? Will the sensitiveness of consciousness keep pace with the growth of knowledge, and obviate the necessity of laborious records? In which case we should have mental and spiritual atavism explained, and that universal sympathy felt by cultivated people for those standing on the lower steps of civilization.

Now, whatever thoughts any other creature than ourselves may have, and leaving out the possibility of mechanical mind-reading in the future, up to this time the only knowledge men have gained about one another's thoughts has been acquired from expression. The expression of thought is language. Dr. Hoffman finds language in rock paintings and carvings; Col. Mallery, in gestures; Mr. Thomas, in the Maya hieroglyphics; and the glossologists, in human utterance. Happily for us, they are a clever set, and well up in their craft. Let us hear some of the questions they are discussing: —

What are all the devices employed by living creatures to express their thoughts, emotions, and volitions?

Which took precedence in the origin of language, signs, or vocal utterances?

What is the explanation of the origin of language?

What light does language throw upon the origin of species?

Is the evolution of language a safe guide to the knowledge of the unfolding of the human mind?

By what lines have the forms of speech progressed?

How far is similarity of language an evidence of consanguinity among peoples?

Is there a genetic relationship between monosyllabism, polysynthetism, and inflection?

What credit must be given to the ear, and the invention of writing, in the conservation, and lines of progress, of language?

How should languages be classified?

Here we may leave the students of language, and take a new guide. Looking over the earth, we behold men divided into races or consanguineous groups, filled with race prejudices, and restricted by race capabilities.

What are those external and anatomical characteristics which have become transmissible by inheritance? When and how were they fixed? Are we to imagine, with Dr. Kollmann, that certain race forms were fixed far back in the past, just as the chemical elements were made irresolvable by a former state of matter?

Of these heritable marks, which is the best criterion of race, — the skull, the color of the skin, the texture of the hair, language, art, social organization, or mythology? or is it certain fixed correlations of these and other characteristics? If so, what are the laws of correlation and conservation in the races? Should the same set of structures be depended on in each race? How many races of men are there? and are these species, or varieties?

In what manner should the question of race enter into the administration of politics, economy, education, and colonization?

It is impossible to say when this subject of race first became attractive to human minds. In the oldest histories and on very ancient monuments, are to be seen attempts to classify the families of mankind. In all the encyclopaedias, under the word 'ethnology' will be found the schemes of modern writers. But, since the commencement of our century, the subject has been taken out of the hands of individuals, and has engrossed the attention of societies. Manuals of instruction have guided the voyager and the traveller in recording the characteristics of races. In Stanford's Compendiums, based on von Hellwald, Mr. A. H. Keane has commenced a codification and synonymy of all the tribes of men. This he proposes to follow up with a biographical dictionary of tribes. The Bureau of ethnology has collated the names, priscan homes, migrations, and bibliography of all the North-American Indian tribes. So that we are in a fair way to know something about the races of men, by proceeding from particulars to a general view.

Passing from man to his works, we are face to face with aesthetic and practical art as a unique study. All art relates to human desires for food, clothing, shelter, for activity in peace and war, for beauty, for social and spiritual happiness. Mr. Tylor has taught us to look upon art products as species that have had an evolution, a life history; and this was very much the plan of Gustav Klemm. This sort of study has captivated many anthropologists, and they are asking such questions as these: —

Admitting that the arts have been progressive, what have been the lines of their elaboration?

May we, by a process of elimination, trace backward the life history of each art, as a patent attorney or a chancery lawyer?

At what degree of workmanship may we be sure that flakes of flint, gashed bones, and wrought wood, give evidence of human handicraft?

When does similarity of art-forms indicate social or commercial contact? when, consanguinity? and when, merely the same gradus of culture?

Is degenerate art a facsimile of early, progressive art?

Is it allowable to fill up the gaps in the arts of any tribe by seemingly intermediate forms from other tribes?

Whence is the sense of beauty?

The answers which we unconsciously give to these queries are the major premises of our arguments respecting the history of civilization.

By marriage in some of its forms, human beings are united into consanguineous groups, whose other needs demand and produce other bonds of union, and widen the separation from other groups. With reference to each set of duties in the tribe, unwritten or written codes embody a system of ethics, regulating conduct in every particular. Farther on in their history, groups have relations of war and peace, and the absorption of homogeneous and heterogeneous peoples into a defined area gives rise to nationalities.

Were men ever herded together in promiscuity?

What were the earliest forms of social life?

What were the most primitive forms of marriage in groups?

Have all the tribes of men passed through the same systems of consanguinity and affinity?

Can the highest systems of altruistic ethics be explained by natural processes?

What are the most beneficial relations of labor to natural resources? and how have the present relations been brought about?

What is the history of the control of the body politic over the individual, and of the jurisdiction of corporations? and to what extent may individual freedom be controlled without discouraging private ambition?

What has been the life history of communism, crime, fashion, and politics?

Is it possible to regard and define facts in sociology by the terms of physical science?

Again, these human beings spend a great portion of their time acting and speaking as if other eyes and ears than those of mortals were cognizant of them. In the darkest nights, at the rising sun, throughout the day, at certain seasons of the year, this unseen world is involved. In groves, in caverns, in estufas, or in costly temples, it is all the same: praises, petitions, and offerings confront the inscrutable power that can work men weal or woe.

How did man come to believe in the animation of things, fetiches, the wanderings of ghost-souls, spirits benevolent and malignant, the gods of classic mythology, and the Great Father of all?

What are the first conceptions of children respecting such things? and will these guide us aright to the childhood of faith?

Has the history of mythology run parallel with the history of material and intellectual progress?

How may we divest ourselves of the personal equation, and learn the true psychology of savage worship?

Is Dr. Brinton right in applying the rules of interpretation adopted for Aryan mythology to American Indian myths, and in assuming that their crude stories are disguised deifications of the phenomena and powers of nature?

Finally, as men wander about the earth, and certain families are to be found chiefly in certain localities, so is it with races. Longevity, fecundity, and vigor are influenced by such causes as height above the sea-level, purity of the atmosphere, amount and distribution of heat, moisture, winds, fertility of the soil, and proximities, whether they be vegetal, animal, or human, whether they be beneficial or injurious.

By what subtle chemistries of the things around us, by what exposures in this terrestrial camera, come to pass the various hues of the skin and hair and eyes, the long skull and the short skull, the long face and the broad face, and the fixed compounds called natural characteristics?

By what processes of selection and adaptation has this cosmopolitan species come to occupy the whole earth, its genial climes, its frozen areas, and its fever-cursed tropics?

Is it possible to control these phenomena, or to adjust the human machine so as to anticipate and assist nature, to expedite natural selection and the survival of the fittest? or even to subdue nature, and decide for her what shall be the fittest to survive?

From this hasty survey of the scope of anthropology, we return to inquire what benefit the world derives from the cultivation of this science.

I answer, firstly, that every study is improved by study. All things become clearer to him who steadily fixes his gaze upon them. The sciences all began with vain speculations, — astronomy with astrology, chemistry with alchemy, geology with cosmogonies, biology with nature-worship, and theology with mythology. Long before the word 'anthropology' was employed in its present acceptation, Alexander Pope wrote, "The proper study of mankind is man." But, millenniums before his day, mankind studied mankind by the light of their time. The study of man is no new thing, therefore. Now, since human thought has run, and will continue to run, in that direction, it becomes our privilege to rejoice that the stream has in these last days run wider and deeper and clearer. The proper study of mankind is the scientific study of man, the multiplication of rigorously exact observations, the collection of thousands of well-authenticated specimens, the classification of both observations and specimens on rational bases, and the limitation of our conclusions to the extension of our premises. Some of my hearers have worked systematically and patiently for years at American archeology, or the anthropology of the modern Indians; and you rejoice with me to-day that our science has at last attained dignity and respect. With profound veneration I mention the names of Hildreth, Atwater, Stephens, Gibbs, Schoolcraft, Morton, Gallatin, Wyman, Squier, and Davis: with what buoyant hope they looked forward to this day, and with what exquisite pleasure must such living witnesses of the beginning as Horatio Hale, Col. Whittlesey, Dr. Jones, and Mr. Hempstead now contemplate the progress of solid work! The Smithsonian institution will have to republish Squier and Davis, with many additions and corrections by Dr. Rau; the Bureau of ethnology will antiquate Schoolcraft and Gallatin and Gibbs; Morton's and Wyman's work will be entirely susperseded by that of the Peabody museum and the Army medical museum. The Archaeological institute of America will throw new light upon the researches of Stephens; and Mr. H. H. Bancroft will make it entirely unnecessary to wade through thousands of pages of ancient Spanish literature. Therefore the first and most beneficial result of modern anthropology has been the direction of an immense amount of rambling and disorganized labor into systematic and rational employment. This clearing of rubbish, correction of misconceptions, cultivation of a modest spirit, willingness to abide the result, multiplication of materials, refinement of instruments, improvement of processes, in a study which thousands are determined to pursue, must strike every thinking person as a wonderful reformation.

Secondly, the value of a study must be estimated by its effects upon human weal. Farmers, miners, fishermen, lumbermen, mechanics, are slow to recognize their debts to the man of science. But who can estimate the millions of dollars saved by such studies as those of Packard, Riley, and Thomas, on the grasshopper, potato-beetle, and army and cotton worms, and the confidence engendered by the belief that a knowledge of the habits of these animals would lead to their conquest? It would take but a few moments to show that this argument applies with manifold force to the study of man himself.

It is not enough for the good physician to know the nature of remedies, or the use of knives and diagnostic apparatus. Sad will be his use of these if he has not familiarized himself with the structure of the human body in health and in disease, and, above all, if he has not made a correct diagnosis of his patient's case. Are not all the questions asked in the first part of this discourse, and many others agitated by anthropologists, connected with human welfare? Do they not relate to the body, mind, and speech of man, to the races of mankind, their arts, amusements, social needs, political organizations, religion, and dispersion over the earth? For instance, the French in Africa, the British in India, and our own citizens in malarious and fever-laden regions, — have they not learned from loss of treasure, ruined health, and the shadow of death, that there is a law of nature which cannot be transgressed with impunity?

It is the same with sociology and religion. The pages of history glow with the narratives of crusades against alleged wrongs, which were in reality campaigns against the sacred laws of nature. Social systems, which had required centuries to crystallize, have been shattered in the effort to bend them to some new order of things. Arts and industries planted in uncongenial soil, at great expense, have brought ruin upon their patrons, who had not studied the intricate laws of environment.

What a modification of temper, for instance, has been wrought among Indo-Germanic peoples by those studies in comparative philology which have led them by the hand back to their priscan home, and demonstrated, that though they may have aggregated into antagonistic nationalities, and fostered inimical industries, the same blood courses through their veins!

The better knowledge of race and race peculiarities has revolutionized and humanized the theories of aborigines. The doctrine of extermination, formerly thought to be the only legitimate result of colonization, has become as odious as it is illogical.

The inductive study of mind has hardly begun; but how much more successfully and rapidly will education and the development of the species progress when the teacher and the legislator can proceed at once from diagnosis to safe prescription, when natural selection and human legislation shall co-operate in the more speedy survival of the fittest! The time seems to me to have arrived when our great anthropological societies and institutions should institute a systematic, co-operative study of psychology.

In a land where the archeologist may tally off most of his finds by savage implements in use at his very door, it seems like presumption to speak to you of the advantages of the most careful archeological methods. But there is a difference between the old and the new archeology. There are times in the settlement of a new country, when every man is his own carpenter, smith, and physician. But how soon your energies have worked out of that! Now I speak only of professional archeology and its advantages. How many mistakes of his predecessors has Mr. Putnam alone corrected? We have all read with pleasure his recent correction of Dr. Hildreth's mistakes about iron in the mounds. It is so with your archeological collections: only those gathered in a scientific spirit will have any lasting value. But in the accumulation and preservation of such, you are the storers of force of the greatest value. You are recovering the scattered fragments of an ancient mosaic which will one day be reset, and its legend will be the lost history of prehistoric man.

The third benefit to which I will call your attention is the opportunity which the science affords for the exercise of every talent, even the highest. The difficulty of any problem depends upon the number or the degree of its unknown quantities. When facts were few, and the data of the science were beclouded with many sources of error, no wonder that men of logical minds left these investigations to those of a more imaginative disposition. Their crude, preliminary efforts have given place to organized work, directed by men of the greatest executive ability, assisted by skilful specialists, and endowed both by private munificence and by public appropriation. Not to go beyond the limits of our own country, we all point with pride to the Peabody museum, the Archaeological institute of America, the American antiquarian society, the museums of New York city and of Philadelphia, the Smithsonian institution, National museum, Bureau of ethnology, Army medical museum, and the Anthropological society at Washington, the academies of Cincinnati, St. Louis, and Davenport, and the historical societies of many of our states, including the Minnesota collections.

Now, the special merit of such great centralization of resources is that everybody can study something. It is possible for every craft and profession thus to prosecute its researches and to make its contributions. During the past winter, papers were read before the Anthropological society at Washington by comparative anatomists, biologists, archeologists, geologists, physicians, paleographers, sign-linguists, philologists, patent-examiners, artists, statisticians, sociologists, clergymen, metaphysicians, and ethnographers. And this does not exhaust the scheme. Mothers, school-teachers, those in charge of the insane, the criminal, and the defective classes, lawyers, mechanics, musicians, philanthropists, legislators, may all contribute to this science some handiwork which will help to make the pile complete. To be still more personal, permit me to say to each one before me, that there is anthropological work which your peculiar occupation fits you to do better than any one else on earth. For example, a distinguished ornithologist, Mr. Henshaw, has recently identified all the birds in the well-known mound-pipes. An artist, Mr. Holmes, has succeeded in bringing order out of confusion in the shell ornaments of the mounds. A patent-examiner, Mr. Seely, traces backward aboriginal art. A general in the British army, Pitt-Rivers, worked out the history of the elaboration of the implements of war. An educator, Mr. Peckham, has recently given us the result of a laborious investigation on the growth of children. The geologists must interpret for us the significance of our discoveries in the drift. Where can I stop? I will boldly avow that the day of tyros is gone. There is a great multitude of collectors throughout our states who will have to go to school to Professor Putnam, or Dr. Rau, or Dr. Thomas, before they will have the faintest conception of the significance of their treasures.

The inevitable result of special research is generalization. Kepler, Newton, Count Rumford, Kirchhoff, Bunsen, and Darwin, are names that stand for these processes in material science. To Herbert Spencer we are indebted for the first effort in this direction respecting human phenomena, and his work will be revised and corrected by those who will approach the task with better instruments and more reliable material.

In this heaving mass of humanity, returning into itself ever with vast gulf-streams and eddies, each actuated by its special forces, there is, after all, orderly motion. We discover that our little circle is part of a greater circle, and for a moment the mind is satisfied in the contemplation of this wider truth. Recovering, and renewing our investigation, the fact is reached, that this and its congeneric circles are part of a greater movement more complicated and perplexing. By the pursuit of this wider knowledge the intellect is strengthened, and thereby is brought about the natural selection of the mind. While many tire, or are unable to comprehend the situation, others press on, and grow strong by the effort.

The last advantage of which my time will allow me to speak is the assistance which such studies render to philanthropy and legislation.

Standing on the deck of a steamer, and looking at the land left behind, we seem to be but a mile or two away. We are surprised with the information, that what seems so near is many miles distant. It is so with human history. In our childhood we believed that the first man walked the earth only a few centuries ago. All the events known to us then could easily have occurred in that brief period. The increase of knowledge expands the boundaries of time, and the origin of man is now lost in the mists of the past. Could any thing fill our minds with greater love for our race than the magnificent struggle they have made in these millenniums? At the other end of the journey we were no better than brutes, and now we look out upon the cosmos as something reasonably comprehended.

If 'pity for a horse o'er-driven' fills the heart of the poet, with what tenderness should we look upon the savage races, and remember that the whole family of man has stopped, some time or other, at that wayside inn! Each aberrant form, abnormality, criminal, dwarf, and giant shows the by-paths of human growth into which our life-stuff may have wandered. The arrow is the parent of the cannon-ball; the stone or bone spear-point, of the bayonet; the flint chip, of all edged tools; the cave-man, of the French *savant;* the hut, of the palace; the tattoo, of regalia; the gorget, of the crown jewels; the quipo and pictograph, of the printed book; promiscuous concubinage, of holy wedlock; the hunting-party, of society; the clan, of the state; the fetich, of the pantheon; and universal animism, of universal causation. Instead of our ancestral belief in a tree with roots in the earth and branches in heaven, our tree has its roots in the past, and is ever putting forth leaves and flowers in a brighter present.

All sciences are retrospective. The astronomer, the physicist, the biologist, find the bases of their prophecies in the past history of the universe. The statesman, if he be wise, will imitate their example, and feel secure of his legislation for the future only so far as it is founded upon an intimate knowledge of the past.

The value of this study to philanthropy is easily shown. With what admiration do we read of the devotion of those missionaries who have suffered the loss of all things in their propagandist zeal! Science has her missionaries as well as religion, and the scientific study of peoples has notably modified the methods of the Christian missionary. The conviction that savage races are in possession of our family records, that they are our elder kindred, wrinkled and weatherbeaten mayhap, but yet worthy of our highest respect, has revolutionized men's thoughts and feelings respecting them. The Bureau of ethnology has its missionaries among many of the tribes in our domain, no longer bent on their destruction, but treating them with the greatest consideration, in order to win their confidence, to get down to their level, to think their thoughts, to charm from them the sibylline secrets. It sounds something like the old Jesuit relations, to hear of Mr. Cushing at Zuñi, eating vile food, wearing savage costume, worshipping nature-gods, subjecting himself to long fastings and vigils, committing to memory dreary rituals, standing between disarmed Indians and their white enemies on every hand, in order to save their contributions to the early history of mankind. You will recall the fact, that an honorable senator more than a year ago offered, as an argument against sudden disruption of tribal affinities, an elaborate scheme of the Wyandotte confederacy. Max Müller says, "He who knows little of those who preceded him is likely to care little for those that come after. Life would be to him a chain of sand, while it ought to be a kind of electric chain that makes our hearts vibrate with the most ancient thoughts of the past as well as the most distant hope of the future."

In the study of this anthropo-cosmos, as in other studies, we are brought face to face with the inscrutable. In these voyages of discovery we have no right to expect that we shall ever find a passage to the ultimate truth. As with the child, so with the man; as with the individual, so with the race; as in the past, so in the present and the future, — the solution of one problem only prepares the way for many far more complicated. With all our sciences comes the consciousness of new ignorances. There is more known to be unknown now than when wise men knew that they did not understand many things well known to us. So will it ever be. Just about one hundred years ago, Peter Camper's measurements of the facial angle, with a few observations on height and weight, were thought to be all that anthropometry could furnish to the natural history of man. In 1881 Paul Broca laid down for the skull and the encephalon more than one hundred and fifty measurements; and the Germans go beyond that. Think you, the weighing and measuring will stop at these? We are just on the threshold of applying experienced training and instruments of precision to the study of man. Examine, if you please, the circulars for information issued by the old Paris ethnological society, Albert Gallatin, Lepsius, Max Müller, and the Smithsonian institution, with those published for the Novara expedition, by the British association, Kaltbrünner, Roberts, the new Paris society, or Major Powell, and you will have ocular evidence of the advance of anthropology.

But there is no Ultima Thule in science. No question propounded to nature will ever be answered. I can imagine the night of despair that would settle around any one of my hearers when he had reached the consciousness of having gathered the whole harvest of truth. On the other hand, I am sorry to hear any of our great thinkers uttering the words *ignoramus et ignorabimus* as a wail of despair. They should be to all the sweet voice of hope. They do not mean that we know nothing, or that we shall ever remain totally ignorant. Fresh, vigorous, buoyant, science feels itself to be on a pleasant journey, whose destination may remain unknown, but every mile of whose progress unfolds new vistas of beauty and variety in nature, each transcending the other.

I congratulate you, dear friends, that the American association has delegated to you such an important trust. The illustrious names to be found among our members and fellows are a sufficient guaranty that you have lighted your torches, and that our science will not be a laggard in this grand march. Professor Henry said, in 1859, "The statement cannot be too often repeated, that each branch of knowledge is connected with every other, and that no light can be gained in regard to one which is not reflected upon all" (Smith. rep., 1859, p. 15). We may go farther, and say, that, whenever any marked generalization is made in any science, all other sciences proceed at once to put themselves in line with the new order. It is the duty of the anthropologists, therefore, not only to rejoice in the growing light of chemistry and biology, but, quickened by their warmth, to put forth new life and vigor, and to apply to their investigations the most refined instrumentalities and the most subtle thought; believing with Lord Lytton that man is a subject of far nobler contemplation, of far more glowing hope, of a far purer and loftier vein of sentiment, than all the 'floods and fells' in the universe.

PAPERS READ BEFORE SECTION H.

(MOUNDS AND MOUND-BUILDERS.)

The great mounds of Cahokia.

BY WILLIAM McADAMS OF ALTON, ILL.

The mounds referred to are in the locality known as the 'American bottom.' The region so called is a strip of alluvial land in the state of Illinois, lying between the bluff and the Mississippi river, and extending from the city of Alton to a point below the city of East St. Louis. A map of the locality, showing the places and dimensions of the mounds, was exhibited before the section. The mounds are over two hundred in number, and are the largest in the United States. A group of seventy-two mounds on the Cahokia creek was specially considered. The central mound of the group is the largest: it is a hundred feet high, and covers fourteen acres of ground. It is a truncated pyramid with two terraces: its flat top has an area of one and a half acres. The surrounding mounds are thirty to forty feet high: they are square, in this respect differing from the conical mounds of Ohio. The mounds on the bluff seem to be of a different order, being only four or five feet high, and round or oval. Unquestionably the mounds of the Cahokia valley are artificial, being made of black alluvial earth, entirely different from the ground on which they rest.

The author accounted for the fact that there were few mounds on the banks of the Mississippi river, by supposing that the mound-builders were afraid of their enemies beyond the stream.

Numbers of relics have been found in the Cahokia mounds, mostly of flint, some of them eighteen inches long. The finest is a white flint axe, which is of a smoothness and polish like ivory. In reply to an inquiry, the author stated that there had been considerable alluvial deposit formed since the mounds were built. The subsoil is a yellow clay loam: under the mounds is a floor of white sand.

In discussing the paper, Gov. Bross stated that he had discovered, on the top of the only round mound of the group, a large flat stone, which he thought might have been used for sacrificial purposes. A skeleton had been found, of a man more than six feet high: the whole series of mounds gave evidence of the energy and industry the men of that time had possessed. Dr. Hoy said that there was in Africa a mere bird that threw up a mound fifteen feet high, so that these men might not have been even large. Mr. Putnam expressed the opinion that the mounds were simply a site for a town, and not a worshipping-place. Mr. McAdams said he had been led to believe they were places of worship, by the use of just such mounds for places of worship in Mexico, their sun-worship being their government. There are few, if any, evidences of habitation.

Metrical standard of the mound-builders, by the method of even divisors.

BY CHARLES WHITTLESEY OF CLEVELAND, O.

In the absence of the author, an abstract of the paper was read by the secretary of the section. An endeavor was made, by the method named, to ascertain the standard of linear measurement which was used by the mound-builders. It is supposed that they, in common with other early races, used the length of some part of the human body as a linear unit. Several theories of the kind were tested mathematically, but, thus far, with only negative results.

The mound-builders identified.

BY JOHN CAMPBELL OF MONTREAL, CAN.

This paper was read by the secretary of the section, in the absence of the author.

It was a pains-taking attempt to trace the origin of the mound-builders in the eastern hemisphere, chiefly by means of a comparison of ancient languages along the line of a supposed route. The line of similarity was believed to indicate that the original people were Khitan or Khitos, Kathaei, Katei, Khilon, or Citem; and that they had made their way across Europe and northern Asia to Alaska, and thence to the United States, down the Mississippi valley, to Mexico.

Professor Mason, the president of the section, expressed the opinion that Professor Campbell was on the wrong track, while complimenting him upon his exceeding zeal and patience in his research. Professor Mason consoled himself, however, with the thought that the author had so thoroughly exhausted the subject that no one would ever attempt a similar experiment. Mr. D. A. Robertson of St. Paul differed from the president, and expressed the opinion that Professor Campbell was on the right track, and that the migration of the mound-builders would be traced from Siberia, or by the European isles, and, if not in one migration, in several.

Typical shapes among the emblematic mounds.

BY S. D. PEET OF CLINTON, WIS.

By means of diagrams, the author exhibited the ground-outlines of different mounds which he had surveyed in Wisconsin, which showed that they had been made in the form of animals, in different postures. There were flying geese, eagles, jack-rabbits, panthers in the act of jumping upon their prey. Many of the supposed effigies were of great size, the tail of one squirrel having a length of three hundred feet. One of the mounds was in the shape of an elephant, with a very pronounced trunk. This mound, however, is now destroyed; and the only authority for its existence is that of a man now dead. There were mounds, also, in the shape of water-animals, such as turtles, crawfish, etc. His theory of these mounds was, that the animals were supposed to be scattered about to guard the central sacrifice or altar mound. He was led to this belief by observing that the altar mounds are nearly always situated on high ground, overlooking a river, while the emblematic mounds are so disposed around the altar mounds, as to suggest the notion of guarding the latter.

Personal observations of the Missouri mounds from Omaha to St. Louis.

BY E. P. WEST.

IN the absence of the author, the paper was read by Dr. Case of Kansas City.

Observations were given with some detail, by which it appears that the Missouri mounds are built on the lower bluffs or terraces. The author shows also that these mounds must have been coeval with the loess deposits. He says we have reason to believe that the occupancy of the mound-builders was prior to the subsidence of the Missouri river and Kansas lakes, and that it was not continued long thereafter. It must have begun previous to the subsidence, since the remains and implements of this people are found in the undisturbed primitive deposits. Their ingress was probably from the south, and extended northward after the close of the glacial period. Turning northward after the close of the ice reign, they found the warm waters of the Champlain lakes filled with fish, inviting an occupancy along their hospitable shores. Here they erected their abodes, and drew their principal food-supply from the lakes. In time, owing to geological changes, the lakes were drained. The conditions for existence being altered, the lake-dwellers either suffered extinction, or were forced to change their mode of life. Their distinctive characteristics, at any rate, ceased long before the European touched foot on this continent. We have no means of knowing whether they were exterminated by neighboring nomadic tribes, or became themselves nomadic in their habits.

Game-drives among the emblematic mounds.

BY S. D. PEET OF CLINTON, WIS.

INDIAN mounds are divided by the author into five classes, as follows: 1. Emblematic, and built by hunters who worshipped animals. 2. Burial-mounds: this class mostly prevails in Michigan, Illinois, and Minnesota. 3. Mounds which are probably the remains of the stockades of an agricultural people. 4. Village mounds, — the remains of villages, and their high places for worship. 5. The peculiar mounds of the Pueblos and Aztecs.

The first of these classes was the special subject of the paper. The author's theory is, that the emblematic mounds, having the form of the animals hunted, served a useful, as well as a religious. purpose. He regards them as having been employed by the hunters as screens from behind which to shoot the animals which would pass along the game-drives between the mounds. Diagrams and charts were used to illustrate the theory.

(OTHER ANTHROPOLOGICAL PAPERS.)

In-door games of the Japanese.

BY E. S. MORSE OF SALEM, MASS.

IN introducing this subject, Mr. Morse said that there are curious affiliations between the Japanese and the American Indians, which may some time show a connection by family ties. Among the simple in-door games of the Japanese are some that are played with balls, jackstones, and cat's-cradle; but all these are more elaborate than with us, and the cat's-cradle goes through a far greater variety of changes. The author believes that the greater intricacy of Japanese simple games is due to the fact that older people take more interest in them. Among these games, there is one similar to 'Simon says thumbs up;' there are tricks with the hands, much like our own; and there are numerous games of striking hands, which appear easy, but require much practice to acquire adroitness. There are many games that test strength or endurance; among them are some in which ears and noses are pulled, and others where the competitors each hop on one foot, and try to push their rivals over.

They have a more elaborate game of checkers than ours. The pieces are placed on intersections instead of on squares. It frequently takes a month to play one game, and the players often deliberate over a move for an hour or two. Experts in the game acquire a wide reputation. Japanese chess is probably the most intricate game in the world. The board has 81 squares, and 20 pieces are used, which have moves somewhat like our own, though none are exactly similar. The pieces change in grade when they arrive at a certain position on the board. The strangest feature of the game is, that either player can take any piece which has been captured from him, replace it on the board, and use it against his adversary. This makes the game utterly bewildering to a foreigner.

The Japanese have no games with spotted and court cards like ours; but they have a card game of 'authors,' which compels players to cap verses of classic poetry. Mr. Morse was delighted to find this intellectual amusement a favorite with the Japanese; and he hopes they will never substitute for it our inferior struggles in seven-up, whist, and euchre.

Life among the Mohawks in the Catholic missions of Quebec province.

BY ERMINNIE A. SMITH OF JERSEY CITY, N.J.

THE paper was an interesting account of the Indians brought under Roman-Catholic influence by missionary labors continued through many generations. These Indians regard their priests as temporal directors as well as spiritual fathers. The manners and customs of the Indians were described, and some account was given of the studies of the author in the

Indian dialects of the province; noting, especially, the more curious peculiarities of the language, the dialectic differences of the tribes, and the modes in which such changes have been effected.

The principal occupation of the men is that of boatmen on the St. Lawrence, though the bead-work goods of the tribe are sold everywhere. The speaker detailed her exciting experience in shooting the rapids of the St. Lawrence, on a raft, under the skilful charge of these Indian boatmen. Many of the laws of the old aboriginal Mohawks are forgotten by the tribe described. The significance of some of the wampum-belts was outlined; and the speaker recited the legend of the old bell in the chapel, closing with a tribute to the zeal and the results of the labors of the old Catholic priests who have worked so long among these Indians.

An exhibition was made, in connection with the reading of the paper, of wampum-belts, drawings of ornaments, and the work of the earlier priests, including some literature.

Observations on the laws and privileges of the gens in Indian society.

BY ALICE C. FLETCHER OF NEW YORK.

This paper was read by the secretary of the section, in the absence of the author.

An elucidation of the customs and circumstances under which the gens system in Indian tribes supersedes parental ties, was the chief feature of this paper. The author had an excellent opportunity for observations of this character, during the work of placing the Omaha tribe of Indians upon their lands in severalty, and while adjusting the line of descent and inheritance according to our laws.

"A child who has lost its father or mother is considered an orphan. Its particular place is gone, and it passes into the gens." Beyond the foregoing statement, the paper does not make it quite clear, whether, in case of the death of the mother only, the child remains somewhat under direction of the father, or is wholly assigned to a family of the father's relatives.

But as to the results when the father dies, leaving offspring, the paper is quite explicit. In that case, the mother loses all maternal rights. Each child, unless of very tender age, will be separated from the mother, and will go into the family of some one of the father's relatives. It may thereafter be claimed as his own child by the male head of the family to which it has been allotted. This separation of her children from a widow is permanent. She usually marries again, and in that event is not burdened with her offspring by previous husband or husbands; but if she should remain unmarried, she would be expected to work for the family that has adopted her children, rather than for the children themselves. If she dies when her children are young, it is probable, that, at maturity, they will have forgotten even her name.

The women are not wanting in affection for the children of whom they are bereft; but the separation is looked upon as a matter of course, none of the interested parties regarding it as a grievance, or even a hardship. It surprises an Indian to have the propriety of this arrangement questioned. No point of our law of inheritance is so difficult for him to understand, as that which binds together the child and the surviving parent.

Young men whose mothers are of the same gens are accounted brothers to each other, and the brothers of the mothers are uncles. Between these uncles and the nephews and neices, there is an easy familiarity, not unlike that of parents and children.

The author has observed a decided lack of family likeness among Indians. This observation applies, however, to entire families, which include cousins, aunts, and uncles; a striking resemblance between parents and children being not unusual.

The Indian may be 'the stoic of the woods;' but he is neither averse to pleasantry, nor deficient in sensitiveness of a certain kind. He delights in chaffing his fellow Indian; and dreads, more than aught else, being made a laughing-stock.

Symbolic earth formationa.

BY ALICE C. FLETCHER OF NEW YORK.

This paper was read by the secretary of the section, in the absence of the author.

By the foregoing title, the author refers to certain heaps of earth which are piled up with care and formality during religious ceremonies of Indian tribes. Miss Fletcher has in previous papers described the preparation of these little mounds among the Sioux, where it formed part of every religious ceremony she witnessed. The present paper described this practice among the Winnebagoes in the 'buffalo-dance,' which is given by them four times in May and early June. The Winnebagoes, the author says, are admitted to be one of the older branches of the great family to which their tribe belongs. Their antiquity is shown by the construction of their language, by finding many religious ceremonies of different tribes referred to the Winnebagoes, and by Winnebago words used by other tribes in connection with religious ritual.

The buffalo-dance was described in detail. As the dancers enter, each woman brings in a handful of fine earth, and deposits it, so that two small mounds are raised midway between the eastern entrance and a fire which is about fifteen feet from the entrance. The mounds thus formed are truncated cones; and an old Indian said to Miss Fletcher, "That is the way all mounds were built: that is why we build so for the buffalo." The mounds were about four inches high, and not far from eighteen inches in diameter. When the mounds were completed, the head-gear of the four male dancers was placed upon them, consisting of claws, tails, and other trophies of the chase. The men imitate the buffalo in his wild tramping and roaring. The women follow in single file, each with her feet nearly straight and her heels together, propelling herself by a jerk of the body, or a kind of hop. The appearance of the entire line of female dancers is suggestive of the undulating movement of a herd of buffaloes. The track left by the women's feet is a regular pattern like a close-leaved vine, each woman hopping exactly into her predecessor's footsteps.

The fire before referred to is built east of the centre of the tent, and contains four logs placed with their inner ends joining, and their outer ends toward the points of the compass. During the initiation of a candidate, at a certain point in the ceremony when he has fallen dead to the old life, and is raised to the new, the four logs are taken away, and the ashes are heaped in a sharply conical mound.

The essayist also described one of the sacred resting-places for spirits on the bluffs of the Missouri river. Such places are at intervals about fifty miles apart. They are cleared and cleaned by sacred hands every year. The place contained a depression in the ground, of circular form except as to an extension of the outline in an elongation or entrance exactly pointing to the east. The depression is just one foot in circumference, and about six inches deep. An adjoining tree, now partly blown down, has the reputation among Indians of being haunted by spirits. The author hoped that other observers would be able to trace the probable connection between these observances and the building of the larger mounds.

Osage war customs.

BY J. O. DORSEY OF WASHINGTON, D.C.

THE paper was read by the president of the section, in the absence of the author.

By means of an illustration the preparations were shown which the tribe makes for a war-march, the order followed being that of rank in the tribe. The paper described the tactics by which the Osages camp in a circle, the war-men on one side, and the noncombatants on the other. The road travelled by the Indians forms the line down through the centre of the camp, and the division-line. The great war-tent is placed with the rear to the west, the place of honor being at the east. The author detailed at considerable length, with the aid of illustrated charts, the method of selecting the forces, and the ceremonials preparatory to war, the decoration of the Kean Woctake, or Cheezhoe peacemaker, the form of the dance around the village, the nature of the moving dance, the order of march from home by twos four abreast. Marriage ceremonials and funeral rites were also described and explained in detail. A marked feature of this paper was its use of drawings illustrating the grouping of participants in ceremonies.

The Charnay collection at Washington.

BY O. T. MASON OF WASHINGTON, D.C.

THE collection referred to contains the material obtained by the Charnay expedition to Mexico and Central America. The expenses of the expedition were defrayed by Mr. Pierre Lorillard. The author of the paper called attention to the fact that Mr. Lorillard was not himself proficient in any branch of science. The success of the expedition showed how a gentleman of fortune might render valuable service to the cause of science, although not specially conversant with scientific lore.

In this expedition, a point was made by obtaining, as far as possible, casts (in plaster strengthened with tow) of the objects of antiquity. By means of these casts, the drawings of this and other exploring expeditions can be verified and corrected. Great success was attained, as to casts from little-known and almost inaccessible ruins; and many new objects of beauty and curiosity were brought to light, among them a large number of interesting reliefs and statues. The casts will be preserved in the museum at Washington, and in duplicate at the Trocadéro museum in Paris. Numerous photographs and drawings were obtained; and measures have been taken, under the auspices of the Smithsonian institution, to reproduce several of the more important ruins by correctly arranging the casts in position with suitable accessories. Good success has already been attained, both in making restorations of ancient temples and other ruins, and in correcting recorded measurements and drawings.

The correspondence between the prehistoric map of North America and the system of social development.

BY S. D. PEET OF CLINTON, WIS.

IN introductory remarks, the author claimed that the American continent was peculiarly favorable for the study of primitive life. The isolation of the continent, and the freedom from historical impressions, had contributed to a unique development. There is no trace of a Homeric age. The symbolism and mythology are homogeneous. In the eastern hemisphere, we have mountain ranges running east and west, which divided races: here we find little trace of such divisions, and the people were to be regarded as a unit.

The theory of the author was, that the development of the North-American aborigines depended upon their surroundings. Dividing the development into three successive grades of savagery, barbarism, and civilization, he found these in successive parallels from colder to warmer climates. The isothermal lines of this continent do not follow parallels of latitude; and due allowance must be made for their deflections to the north and south, in considering the effect of climate upon development. The author differed from Mr. Morgan on certain points. The production of pottery is not so certain an evidence of emergence from barbarism as is the pursuit of agriculture. While Mr. Morgan regarded the development of village-life as a distinguishing feature, Dr. Peet had found traces of village-life everywhere among the aborigines.

In respect to the origin of the American races, the author believed that some aboriginal tribes came from the east, and others from the west. It is possible that this diversity of descent can be detected by careful observation of the tribes on the Pacific coast.

The kitchens of the east.

BY E. S. MORSE OF SALEM, MASS.

The author, during his travels in eastern Asia, had made some observations on the cooking-apparatus there in common use. The Japanese largely employ a mere fireplace, over which the vessels containing food are suspended by hooks: they have, however, two or three kinds of regular stoves of different designs. In China, stoves of a definite character are in use: one was found in Canton which was very elaborate; it was long, and had numerous openings. In Singapore, there appears to be only one kind of stove; and it is of decidedly primitive construction. In fact, it is little more than a rough trough filled with earth and sand, on which are laid rough stones selected with reference to pots of various sizes; and the fire is built among the stones. The kitchens in which these constructions are found are invariably very dark and dirty. In northern Java the author found a stove made of arched clay, as half an earthen pipe would be if cut through the axis of the cylinder. This half-cylinder is set with the open part down, and fire is built under its arch. Holes are cut through the crown of the arch, to hold some of the pots, while others are merely set upon the surface.

Methods of arrow release.

BY E. S. MORSE OF SALEM, MASS.

The author recited the rules at present applied in the American system of archery; the bow being drawn with the right arm, the arrow being placed on the left side of the bow, and three fingers being used to hold the arrow. Among the Japanese, a different system prevails: the arrow is placed on the right side of the bow as it is held perpendicularly, and the drawing of the bow is performed with only the thumb and one finger on the shaft. China, Japan, and the Corea are alike in this manner of drawing the bow. Among Indian tribes, the methods of arrow-release differ very widely. In general it may be stated that our system of arrow-release (which the author designated as the Saxon method) is substantially the same as that of the majority of European races, the modifications of the system among them not being important.

The Japanese use a glove with a heavy thumb, and sometimes a heavy ring on the thumb. Mr. Morse exhibited the Japanese archery-glove. It has a filling of wood and pitch in the thumb, which aids in grasping the arrow. He considered this glove the best of its kind.

Our system of three-finger release is certainly as good as any other, and probably is the best. With this system our archers — for instance, some in Ohio — are able to outshoot any Indian, tried by all the usual tests. As to the methods of stringing the bow, the author had not been able to find much uniformity. A number of different modes were exhibited.

Vestiges of glacial man in central Minnesota.

BY FRANC E. BABBITT OF LITTLE FALLS, MINN.

In the absence of the author, this paper was read by Mr. Upton.

The field of the discoveries detailed in this paper lies on the bank of the Mississippi river, in central Minnesota, about one hundred miles north-west of St. Paul, and within the township and village of Little Falls, Morrison county. In his report for 1877, Prof. N. H. Winchell, state geologist of Minnesota, described certain rudely worked pieces of quartz discovered by him in this locality. The author of this paper describes a discovery of worked bits of quartz in a much older stratum than the one explored by Professor Winchell.

Fragments of sharp, opaque quartz were found by the author in 1879, in a gap or notch, cut by drainage, in an ancient river-terrace, which has an elevation of twenty-five feet above the present river. The gap had been deepened by use as a wagon-track, which has latterly become a highway. Ultimately the source of these fragments was traced, and found in the form of a thin layer, situated from ten inches to two feet above the point in the notch where Miss Babbitt began her discoveries.

The ancient terrace consists of stratified gravel and sand. The layer of quartz-chips extended in a nearly horizontal plane into the terrace, and was partially broken up on the edge where the gap, with its wagon-road, had disturbed a portion. Both the inferior and superior planes of the quartz-bearing stratum were sharply defined: its thickness averaged a few inches, varying a little with the size of included pieces. The quartz-bed rested upon a few inches of sandy soil, which passed downward into a coarse water-worn gravel immediately overlying till. Above the quartz-bed, stratified gravel and sand extend up to the surface of the terrace, which is twelve to fifteen feet higher than the plane of the quartz. The pebbles of the gravel lying directly on the quartz were small well-rounded, and less angular than those of the gravel below. These observations show that the quartz-chips were spread originally upon an ancient surface that was afterward covered deeply by the modified drift that forms the terrace. The quartz-chips and implements discovered by Dr. Winchell were in the upper stratum of the terrace-plain. The two sets of objects cannot be synchronous in deposit: between the periods when they were left there, an interval of time must have passed sufficient for the deposit of twelve or fifteen feet of modified drift.

The specimens are mostly small, and very numerous. Among them are some of a type unknown to the author, of which the most finished have delicate, fragile edges, formed by a single thin leaf of the quartz prolonged beyond the mass of the object in a series of minute, irregular notches. The specimens of different types were found in groups, each of its own type, in this deposit. Some are thus described: 'Axe-like quartzes,' 'rasping-stones,' 'long prong-shaped objects,' 'hammer-stones of different shapes, sharp pieces adaptable as cutting-blades, and a great many sharp and long splinters.' They are made of many different varieties of the quartz mineral; but the greater part appears to have been taken from quartz-bearing slate in the vicinity. Numbers have evidently been formed from water-worn pebbles. Objects shaped from some special variety or tint of quartz were found generally together in loose groups of two or three to a dozen pieces. Where a piece is of large size, the chips surrounding it are usually much smaller.

Professor Henry W. Haynes of Boston, to whom a collection of the specimens was submitted, has written, that he believes some of them to be implements; many, chips and refuse struck off in the work; many are natural forms, and a few are rolled pebbles. Those which he thinks are implements, he supposes were held in the hand of the workman; masses of quartz were fitted for use by having most of their projections battered off by another stone. He believes, also, that he has found traces of moss or leaves being used to soften the roughness of these implements when held in the hand.

Mr. Warren Upham, assistant of the state geological survey, contributed the following statement on the subject, showing how man could live while the modified drift was deposited, and how relics of his work might be enclosed within that formation. He says, —

"As soon as the ice had so far retreated as to uncover the present valley of the Mississippi river in Morrison county, the deposition of the modified drift, constituting the terrace-plain in which are found the quartz chippings, ensued, during the continued retreat of the ice. It seems very probable, that vegetation and animals followed close upon the retiring ice-border; and that even man, who lived near the Atlantic coast in this closing stage of the glacial period, as abundantly proved by recent discoveries in the drift-gravel near Trenton, N.J., may also have lived here at that time, and occupied the Mississippi valley directly after the ice-sheet retired. While the deposition of the valley-drift at Little Falls was still going forward, men may have lived there, and left, as the remnants of their manufacture of stone implements, the multitude of quartz fragments here described. By the continued deposition of the modified drift, lifting the river upon the surface of its glacial flood-plain, these quartz-chips were deeply buried in that formation. The date of this valley-drift must be that of the retreat of the ice of the last glacial epoch, from whose melting were supplied both this sediment and the floods by which it was brought. The glacial flood-plain, beneath whose surface the quartz-fragments occur, was deposited in the same manner as additions are now made to the surface of the bottom-land; but the flooded condition of the river, by which this is done, was doubtless maintained through all the warm portion of the year, while the ice-sheet was being melted away upon the region of its head waters. In spring, autumn, and winter, or, in exceptional years, through much of the summer, it seems probable that the river was confined to a channel, being of insufficient volume to cover its flood-plain. At such a time this plain seems to have been the site of human habitations and industry, as shown in this paper. After the complete disappearance of the ice from the basin of the upper Mississippi, the supply of both water and sediment was so diminished that the river, from that time till now, has been occupied more in erosion than in deposition, and has cut its channel far below the level at which it then flowed, excavating and carrying to the Gulf of Mexico a great part of its glacial flood-plain, the remnants of which are seen as high terraces or plains upon each side of the river."

An animated discussion followed the reading of Miss Babbitt's paper. Mr. Putnam referred briefly to the discoveries made by Dr. Abbott in New Jersey, some of which are unquestionably artificial productions, and prove that man resided in that region prior to the last glacial deposit, or, as some claim, between two glacial deposits. The discoveries made here seem to be of the same character as those in New Jersey. Their age belongs to geologists to ascertain. He considered the discovery very important, and the paper one of great value. Rev. Mr. Peet took issue with Mr. Putnam as to the value of the discoveries, and thought, that, if paleotiths had to depend upon such a shallow foundation as was furnished by these alleged discoveries, the matter would better be dropped. He thought there was absolutely no evidence that the specimens discovered by Miss Babbitt were the work of man, and was of the opinion that the whole theory was without any foundation whatever.

A classification of the sciences.

BY J. W. POWELL OF WASHINGTON, D.C.

THIS is an endeavor to classify sciences in the order of the evolution of phenomena, and with reference to complexity. The first group of science, relating to physics, the author divided into molecular, stellar, and mechanical science. In the second group, the biological sciences, he placed botany and zoölogy. In the third group, anthropology, we have pyschology, sociology, philology, technology, and philosophy. Geology is a compound of the first group; paleontology, of the second.

The following subdivisions of the third group were suggested: As branches of philology: 1. sign language: 2. spoken language; 3. written language. Under technology: 1. activital; 2. regulative; 3. ethics. Under philosophy: 1. mythology; 2. metaphysic; 3. scientific. Technology is also either industrial or aesthetic. The author explained in further detail the reasons for this order of classification, and the relations of the members of different groups to each other.

List of other papers.

THE following additional papers were read in this section, some of them by title only: An ancient village of the emblematic mound-builders; caches guarded by effigies; effigies guarding the village and sacrificial places not far away; high places connected with ancient villages; The religious structures common to villages in prehistoric time, by *S. D. Peet*. An abnormal human skull from a stone grave in Tennessee; A new stand for mounting skulls, devised by E. E. Chick, by *F. W. Putnam*. Accidents, or mode-signs of verbs in the Iroquois dialects; Studies in the Iroquois concerning the verb 'to be,' and its substitutes, by *Erminnie A. Smith*.

PROCEEDINGS OF SECTION I.—ECONOMIC SCIENCE AND STATISTICS.

ADDRESS OF FRANKLIN B. HOUGH OF LOWVILLE, N. Y., VICE-PRESIDENT OF THE SECTION, AUG. 15, 1883.

THE METHODS OF STATISTICS.

I INVITE your attention to a few thoughts upon the *methods of statistics*—using the term 'statistics' in its broadest sense, as a 'statement of facts.'

The subject naturally divides itself into two distinct operations,—the collection of the data from which information is to be obtained, and their classification in a manner that shall without error, and with the least labor, present the results in a form most convenient for use.

Commencing with the first of these,—the collection of facts,—it would be needless to remark, that every thing depends upon the simplicity, accuracy, and completeness with which they are obtained, and that by no subsequent operation can their errors be eliminated, or their deficiencies satisfactorily supplied.

It may be remarked, in general, that no intelligent person, business firm, or corporation, can safely begin any enterprise,—nor can any government, from the lowest municipal to the highest national form, undertake any measure with prudence,—without first knowing all that can be ascertained beforehand concerning it.

In private business, inquiries are naturally made as to the cost and the profits. If it requires the use of a raw material, the parties will endeavor to make themselves sure as to its abundance,—the probability that the supply will be maintained,—or, if it be of limited amount, the quantity, and the time that it will hold out. They will need to know the changes that may happen in amount, quality, and cost; and similar inquiries will be made as to the expenses that may be incurred while in their hands,—the chances of loss, or of change in value,—and, finally, the extent of the demand for whatever may be the product of their skill, industry, and investment, its probable permanence, and its tendencies to change.

These questions, being well considered in the beginning, will enable the careful operator to avoid losses from imprudent investment, from over-supply of the markets, or from the depression of receipts below the limits of cost.

By a train of reasoning analogous to this, those intrusted with the government of towns, cities, or states, may determine as to how far the cost and maintenance of public enterprises will be justified by the results; but with this difference, that the benefits or profits, instead of being measured by a money value, are often to be found in an advancement of the public welfare, and in the security, convenience, and prosperity that may ensue.

But, whether in private enterprise or public undertaking, we may attribute success alike, in both, to an attentive notice of the facts and the circumstances upon which they depend; and, if loss or failure follow, the reasons may very generally be traced to ignorance or inattention as to the facts and probabilities that should have been known beforehand.

These thoughts lead us directly to the point we are first to consider; viz., How shall the knowledge of the required information be obtained? In the primitive way (and for a small business this may be the best one), the person will, from his own observation, 'look over the ground,' and consider the various points to be taken into the account. He will make inquiries of others, as to the supply, demand, prospects of competition, and the like; and thus accumulate a certain amount of information, upon the extent and accuracy of which, his success or failure will in a great degree depend.

Advancing a step farther, we find, in most great industries and interests of the country, that those in the same business or pursuit, whether in the arts or sciences, or in financial operations, however they may be influenced by local rivalries or petty jealousies, are constantly tending to the formation of associations or societies, for the advancement of their common interests. They meet for the discussion of methods by which expenses may be saved, or profits increased. They inquire of one another as to their experience or observation upon doubtful points. They seek to gather light and aid from science, to stimulate and reward invention, and to excite rivalries in the comparison of improved products. They discuss financial and national questions that may affect their welfare; and not unfrequently they appoint committees or agents, from their own number, to gather statistical facts and details for their own use and guidance.

We consider the information thus obtained, as deserving high rank in point of accuracy. It is chiefly taken from records, without a motive for concealment or evasion, and with a full knowledge that self-deception and loss would result from error, whether above or below the truth.

From this combined experience, each member who participates obtains a standard for comparing his own results with the general average. He cannot afford to fall below it, and he has the strongest motives for reaching the highest limits that have been reached by others.

Still these statistics, however accurate they may be, are necessarily special, and often technical in their nature. They cannot be compared with those of another business, and may be incomplete within themselves, as naturally relating to methods, rather than to financial details. They might show *how*, rather than *how much*. They will seldom contain a balance-sheet of profit or loss, or any thing that would advance the fortunes of a rival in business, or reveal the secrets of an unprofitable enterprise. We must receive them as we find them, — good only as far as they go.

Besides these associated business inquiries, prompted and guaranteed by self-interest, we find various others, voluntarily undertaken with reference to particular subjects, often for the promotion of a moral, religious, benevolent, educational, or political object, and ranging in value all the way between the accuracy of statements taken from records, or gathered by faithful inquiry, by chosen special and zealous agents on the one hand, and the random conjectures carelessly returned by those who know but little, and care still less, about the subject of inquiry, on the other. It would be wholly impossible to assign a scale of value to statistics thus obtained, where every thing depends upon the circumstances of the case, and the accuracy of information on the part of those who make returns, — the fulness with which they are reported, and the care with which they are combined.

We have another class of non-official statistics collected and published by private enterprise, for the information of particular trades or professions, or for use by the general public; their reputation and success depending wholly upon their accuracy, and being brought to the test of local and personal knowledge every day and everywhere, we may naturally expect them to be as accurate as they can be made. In this class, we may include directories, trade and market reports, financial transactions, and the current commercial statistics generally.

There may be instances where they are tainted with a suspicion of private or speculative motive: but such is the vigilance of rival enterprise, that detection will quickly follow; and an exposure would at once degrade a reputation for independence and impartial statement, to the rank of a private job for a speculative end.

Exhibits openly made, for the avowed purpose of presenting the favorable side of a business enterprise, may be taken for what they are worth, and are often trustworthy; but, when concealed under a false pretence, they deserve suspicion, and, when exposed, they generally injure the interest that they represent.

The best of these statistics are taken from records, and are entirely correct; others are collected by special agents, and should be approximately near the truth; and there is still another class, made up from the estimates of those supposed to know the facts, and which must wander more or less from the actual conditions that they attempt to represent.

It may be said of all of them, that their greatest value is for present use. They quickly pass by, to give place to the next issue, and remain only as historical records; but, as such, they still afford a most valuable means of comparison between the present and the past, and become landmarks of progress, ever instructive to those who may be seeking to trace the origin and growth of our industries and our resources; and now and then they are recalled as precedents, where new questions arise, under circumstances deemed similar to the past.

We will next consider some points relating to inquiries undertaken by authority of government, either for the intelligent discharge of its own functions, or for general information, the good of its citizens, and the advancement of knowledge among mankind.

We may, in general, remark, that nothing can be properly done, in the machinery of government, without leaving its record. If money or property is received, there is an entry; if a payment is made, or if property is issued, there is also an entry, and a receipt to prove it. In short, the whole theory of our government involves the necessity of a record of every official transaction; and it is only in cases of intentional fraud, or gross neglect, or unavoidable accident, that the history of every public act cannot be traced from these records.

A record, to be trustworthy, should be made at the time of the transaction, and while all the facts as to time, subject, and amount, or other points of statement, are fresh in mind. Nothing should be trusted to the memory, and for record at a more convenient season. It should be concise, and easily understood, and may often be very greatly assisted by tabular arrangement.

The summaries of these records, as published by the government, are, we believe, with few exceptions, entitled to great confidence, as far as they present transactions done by authority, or passing under the notice of government agents.

We may classify the official statistics of the government under the following heads: —

First, Summaries of current business, published annually or at shorter intervals.

Second, Periodical inquiries made at wider intervals, as in the census, and requiring special agencies for their execution.

Third, The inquiries made by experts, or by special commissions or agencies created for a particular purpose. This class is sometimes associated with one or the other of the preceding.

Taking from among these classes the census, as one of the most important, let us notice some of the methods by which it has been taken.

The earliest returns that I have found, in colonial times, were made by sheriffs and constables. At a later period, the national census was for a long period taken by the marshals of the district courts, or their deputies, — officers whose duties are quite analogous to the former; and this practice of assigning the task to sheriffs still prevails in several of the states.

In many other cases, assessors discharge the duty. In New York, before 1855, special agents were appointed by local authorities; and, commencing with that year, they have since been appointed by the secretary of state. The appointing power has been vested in state boards, in boards of county commissioners, and in the judges of inferior county courts. Assuming what I think all will admit, that census inquiries should be made entirely free from any suspicion that some tax or some personal liability is to be incurred, it is evident that an assessor cannot question an ignorant man about his property and his crops, without exciting his fears that some tax is to be laid. The sheriff or the constable seldom makes a professional call, except to serve some papers or make an arrest. There is, therefore, a strong reason for appointing persons who are to make the census inquiries their only business, and for making it widely known that there is no taxation, enrolment, or other liability incurred by giving full and true returns, and that there is no sectarian or political end to be served by the inquiry.

This excellent end is now well enough secured under the national law, and in several of the states. They have a still better method in Great Britain, where a system of registration of births, marriages, and deaths, has its districts and its agents under constant organization, and to which, once in ten years, the census can be assigned, without creating new offices. In Sweden, where a system of registration, including also a record of change of residence, is in charge of the parish-clerks, they take a census whenever they choose to post the books, without any special inquiries being made, more than what these records contain.

In the national census before 1850, — in New York before 1855, — and in some of the states still, each family had one line upon the blanks; and the number of persons of different ages, sexes, and colors, was entered in columns provided. The limit of classification was of course restricted to these columns; and, although the totals of each class were easily obtained by adding, the results were meagre and unsatisfactory.

The change that allowed a line for each name, one column for the exact age, and other columns for native country, profession or occupation, etc., while it simplified the labor of taking, allowed ample field for classification; and it made it necessary to employ a large force of clerks, in a central office, for the reduction of the returns for publication.

By a method now generally used in Europe, the census is taken upon 'householders' schedules,' which are distributed one to each family, some days beforehand, filled out by the head of the family, and collected upon *one day*. The only instance in which this has been done in the United States, within my knowledge, was in the District of Columbia, upon the 11th of November, 1867. This census was taken by the metropolitan police, under my own direction, and with entire success. It was attempted in the city of Baltimore some months afterwards, and failed, apparently from want of proper management on the part of those in charge.

For all kinds of official inquiries, relating to business, as well as to personal statistics, I think the true and proper method is, by means of *special blanks*, carefully prepared, simple, and fully explained. These should be distributed some little time beforehand, and should be taken up, if not in one day, within a short period of time, but with reference to a given day. The chief difficulty to be encountered is the illiteracy of those who should fill the blanks; but in the District of Columbia, which in 1867 contained a large number of colored families, but recently freed from slavery, the blanks had been, in almost every case, filled out by some one to whom they had been carried.

In following our subject, — the 'methods of statistics,' — we may notice some points in the condensation and arrangement of facts that may be of interest.

With a vast amount of information before us, as, for example, in the returns of a census, let us consider what is to be done, and how it can be done with the least labor and greatest certainty. After inspection to make sure that the work is all together, in proper order and condition, it will be found that several distinct operations are necessary, in preparing the results for the press. Columns of figures must of course be added, and carefully revised. As the totals of several sheets will often be consolidated into one sum, it is best to use spare sheets of the same schedule for entering the totals of pages, so that these partial totals can be easily combined. It is always a good practice, where long columns, of many figures in each, are to be entered for adding, to provide paper with narrow vertical ruling, that shall allow of but one figure in a space. In cases where the first two or three right-hand characters are generally ciphers, they may be left out altogether, the significant figures only being entered in their proper places. It saves a little time and labor, and does not lead to error.

Where a great amount of statistical material is reported, — as, for example, the names in a census, — the blanks should always be plainly divided by horizontal and vertical lines, *printed in preference to ruled*. The horizontal lines should be numbered from the top downward, upon both margins. This numbering is the more important where an entry is carried across to another page. Each line should contain but one entry, and there should be, if possible, no blank lines except at the end. Then, with a little multiplication-table at hand, showing the number of lines in a full sheet, and for each number up to the highest that are likely to be found in a return, the totals can be rapidly and accurately ascertained, as follows: The number of sheets is first counted on the back edge, and the number of entries they should contain, if full, is set down. Then, by glancing over each page separately, it is easy to notice whether there are any lines with two entries, any blanks, or any lines in excess. The deficiencies are set down in one column, the excess in another, and their difference is added or subtracted, as the case may require, when the true sum is at once found. This operation, which is the first thing done, should be repeated by another person; and, when found to agree, it should be kept as a test-number for verifying the accuracy of much of the work that is to follow. In measuring parts of pages, a scale made of a strip from the margin of a blank schedule, and pasted upon a card, will save all labor of counting.

In statistical labors, where the same returns afford material for a considerable number of deductions, — as, for example, the population sheet of the census, — it is generally best to take *but one thing at a time.* Thus, the ages, professions, nativities, civil condition, etc., should be taken by separate operations, and not two or more at once. There is not, however, the least need of confusion in keeping the subdivisions of these subjects, in two or four classes, — as, for example, ages by sex and color, — by a simple arrangement of heavy and light horizontal lines upon the tally-sheet, and a little practice in its use.

There is much to be gained, both in time and accuracy, by a proper arrangement of a tally-sheet. The grouping together of tally-marks, by making four down and one across, so as to divide the work into groups of fives, is so natural and obvious a method, that few who have had occasion for this kind of work could have failed to adopt it. By an arrangement which I have used to a large extent in census work, I have had my tally-sheets printed off into squares, so that each compartment should receive one group of five, and no more. Then, by a series of numbers with a common difference of five, printed across the top of the sheet, at the head of each vertical column, the number of tally-marks in a horizontal row can be known at once, by glancing along the vertical column containing the last full group of fives, to the number printed at the top, and then adding the marks in excess, but less than five, in the next compartment. This saves all counting, and a considerable amount of time. There is also an advantage, on account of the eye-sight, in having the tally-sheets of some other color than white: a neutral tint might be best, but I have found common manilla paper answer every purpose.

Plans have been proposed for using cards of different sizes and colors, properly inscribed or numbered, as counters, for classifying a variety of facts, forming together a definite whole. By using colors, the eye becomes, without mental effort, a guide to the hand, in their distribution into piles or cells in a case; and, when the work is done, their number may be accurately known by weighing, or by measuring the height of each pile. Those of different sizes could be separated by mechanical devices, without handling, and, by a little practice, without liability to error.

It may be said generally, that the chief, indeed the only real, difficulty, in the preparation of statistical data, consists in getting the facts correctly. There is nothing in the operation of a central office that needs to involve error; or, if an error is committed, there should be no difficulty in tracing it to the clerk who is responsible for it. An efficient way to secure accuracy in work would be, to make a money-charge against the clerk who commits an error, to be paid to the one who finds it. I believe that something of the kind is done in some of the statistical offices in Europe, a class of revisers being employed, who are paid by the fines thus imposed upon the careless.

With respect to statistics obtained by circulars addressed to persons supposed to have the information desired, we have every grade of value, from good to good for nothing. The result depends upon many circumstances: as, for example, whether the person making the return is paid, or is under some obligation to, or expects some favor from, the person or office making the inquiry; whether the inquiry can be answered by reference to a record, or by some research more or less conveniently made, or is to be supplied from personal opinion, and a general knowledge of the subject; or, finally, whether the question can be answered by any thing better than a guess, by one who knows perhaps very little about it.

I would hold it to be the general rule, that where the inquiries are few and simple, exact as to their object, and, if they refer to a record, exact as to time and subject, and especially if they can be returned upon the same blank, and without expense for postage or otherwise,a very large percentage will be answered without a second application. A repeated call would probably bring a third or a half of the remainder; but there will be, now and then, one who will fail to reply, unless under official or personal obligation to do so.

We have thus far considered the dealing with statistics that have been gathered from the whole of a given field of inquiry: there are other methods that deserve notice, and the first of these is that 'by samples.' A portion of some whole is carefully studied, and the results obtained are deemed applicable to the entire field.

The French statistician Moreau de Jonnès has given some instances of this method, as applied in times past, by persons who had acquired eminence, and whose work gained confidence; and very properly asks, 'What is such work worth?'

Vauban, distinguished as a military engineer, at the beginning of the eighteenth century, wishing to know the agricultural production of France, and the revenue it would yield, resorted to a method which would appear strange enough now, but still may be called ingenious. He attempted to reach his object by taking an exact account of the production of a square league, reckoning the arable land, vineyards, pastures, and woodlands, with their products in quantity and value; and then, by the simple "rule of three," he said, "as 1 is to 25,000, so is the result to the whole of France."

The English agriculturist, Arthur Young, sought to ascertain the proportions of meadow-land, mountains, and the like, in France, by cutting up a map by lines following these features of the surface, and weighing the parts.

In 1790 Lavoisier, distinguished in science, and for this reason consulted by the national assembly upon a question of imposts, found no existing data that applied to the internal resources of the country, until he himself supplied them, by a method that is now altogether neglected in statistical researches. He proposed to ascertain the number of ploughs in the country, and from this to calculate the quantities, production, and consumption of agricultural crops.

In 1784 M. Necker, the distinguished statesman, deduced the population of France from an assumed percentage of the birth-rate; and this was taken for a census!

But coming down to a much later period, we find a remarkable application of the law of induction in a work upon the industries of France, by the minister Chaptal. He presents agricultural tables, which have been received with great confidence, since they bear the appearance of official statistics, and were executed under the Empire. His tables are found to have been computed, without acknowledgment, from a statement addressed by M. Hennet, director of the cadastral survey, in 1817, at a time when not more than a seventh part of this work had been finished. The other six-sevenths were obtained by a simple multiplication of the finished part.

Many years ago, a 'distinguished statistician' published, with great apparent precision, the yield of potatoes in France. There had been no official inventory taken; but when one came to be made, some time afterwards, it was found that this deduction had been obtained by mutiplying the yield of a single commune by 37,000, the number of communes in France.

These examples might be multiplied indefinitely; and we need not cross the Atlantic, nor go far back in time, to find them. There is scarcely a day, but that we see passing through the newspapers, estimates, deductions, and statements, that have no more solid foundation than those that we have cited. Nevertheless, we must not wholly disregard the inductive method in statistics: there are many cases in which we can get nothing else.

The chemist must analyze the soils and the ores from samples. In every operation of testing the quality and the value of any commodity whatever, we must select from the material before us what appears to be the average quality. And so of statistics generally: if there is no actual and general inventory made, we must collect from what is deemed a fair average, and, from these data, obtain such conclusions as they afford. The result in this, as in every thing, will depend upon the intelligence and honesty of the person who makes the estimate, the extent of his opportunities, his experience, and his skill.

Returning to the field of exact statistics, we may remark, that we can never have an accurate census of the population until we have a thorough and uniform registration of births, marriages, and deaths; a measure which this association undertook to promote, more than a quarter of a century ago, but which has not made successful progress.

We cannot have a faithful statement of the industries, without a record kept of the production, the consumption, and the cost of operation. This is already done by most of the important ones, as an incident of business; but we lose the advantages by the hurried manner in which the official inquiries are made. Yet upon these returns we rely for all that is collectively known about them.

It follows, that, until we can realize these desirable features, the best we can expect is, to afford more time for previous preparation, by submitting beforehand the questions that are to be answered; which can only be done by the aid of 'householders' schedules' for population, on 'special blanks' for each of the industries, or other subjects, that come within the range of inquiry.

It was my intention to dwell at some length upon the illustration of statistical facts by graphic methods; but time will not permit, and opportunity for full preparation has not been found. For more than thirty years I have been accustomed to note down the principles involved in these methods, whenever, in the course of a wide and varied range of opportunity, a new one was found; and it has been with me a cherished intention to present the whole subject in a systematic form.

We may concisely state, that graphic illustrations, using lines, areas, or angular spaces, often supplemented by colors, may be employed for representing either —

1. *Quantities*, with or without reference to time.
2. *Time*, in recurring, interrupted, or progressive periods.
3. *Direction*, or *relative position*; and
4. *Intensity* or *force*.

In general, but two elements can be clearly presented at once; but by a skilful use of different colors, or kinds of lines, subjects of the same nature may be admirably compared, and the relations of cause and effect not only illustrated, but even discovered and proved. It is often admissible to introduce subjects having dissimilar notation, — as, for example, degrees of temperature, and height of barometer, — in the same drawing; but in these cases each must have its own scale, and, in a general way, every diagram must have a scale for every element of the subject that is represented, either expressed or implied.

Quantities may be shown either as they exist at certain periods of time, or as they form parts of a general total; and they may be presented so as to exhibit successive subdivisions, down to any desirable degree. If the divisions of a general total do not require subdivision, they may best be shown by angular spaces, as sectors, which together make up the whole of a circular area. If the divisions have some qualities in common, the shades of color may be of different intensity, significant of the degrees of quality that may exist. But where there are successive subdivisions, or *parts of parts* of a whole, there is no way so exact as by means of rectangular areas, which may also be shaded in different tints, as well to separate them one from another as to show differences of intensity or degree.

In both of these methods, as well of angular spaces as of rectangular areas, we can only show quantities as they exist at a given point of time. We catch, as it were, the conditions, as does the light, the image in a camera. They admit of no such thing as motion or change; but these changes may often be strikingly represented by a series of diagrams, presenting the conditions at different periods of time.

Where time and quantity are combined, we have an easy and striking means of illustration; and in this the time may be in recurring periods, such as the hours of a day, or the months of a year, or it may be progressive, as in a series of years.

For the recurring periods, I think there is nothing so convenient and instructive as the *circle*, in which the quantities are measured along the radii, from the centre as their base. The entire radius may sometimes represent the whole of that of which these partial measurements are a part.

For a progressive series, the ordinates representing quantities should be measured from a level base-line, and the scale of graduation shown upon the side margin, while the time is measured from left to right by a scale along the upper margin.

For simple comparison, a series of bars or lines, measured from a common base, and either horizontal or vertical, is a convenient and striking mode of illustration, and has now come into very common use.

A rectangular area, with parallel divisions, amounts to the same thing as a line; but with this difference, that a secondary subdivision may sometimes be represented with great effect.

Having thus stated some points in reference to graphic illustrations upon a true principle, I should not leave the subject without a word of censure for some that are false. I will specify, particularly, such as attempt to represent comparative quantities by *concentric figures*, such as circles or squares. The eye has, in these cases, no means of just comparison; and they are very apt to mislead, where they are intended to instruct.

The same objection may be made against similar geometrical solids; for, although they may be literally true, their contents being to each other as the cubes of similar lines, the eye does not readily see the difference. It would be better, in such cases, to use cylinders or prisms of the same base, but proportioned in length to the quantities that they represent.

PAPERS READ BEFORE SECTION I.

Life-insurance and self-insurance.

BY ELIZUR WRIGHT OF BOSTON, MASS.

THIS subject has been a favorite theme with Mr. Wright for several years. His ability as an actuary is acknowledged; and his theory on this subject has at least the merit of disinterestedness, so far as insurance-companies are concerned. Without going into the technicalities and mathematical considerations that must be met in a thorough review of Mr. Wright's theory, its object may, perhaps, be stated correctly in a few words. A reserve is accumulated by the practical workings of life-insurance in a well-regulated company, which is more than sufficient to meet the claims upon it as fast as they mature. The usual system divides that reserve, less the amount which the company withholds as a surplus for extraordinary emergencies, among the policy-holders. Mr. Wright takes the view that each policy earns, during its continuance, an ascertainable part of that reserve. He supplies the means for determining what this part is. for each policy: of course, it is a matter of calculation for each. He denominates this part of the reserve, or surplus, the 'self-insurance.' By his system it is possible to ascertain at any time how much this self-insurance on a given policy amounts to, or how much it will amount to at any future time, if kept in force. Mr. Wright believes that the self-insurance is the property of the policy-holder; and that, if not payable to him on demand, it should at least be applicable for a renewal of the policy to prevent forfeiture.

The increase of the colored population of the United States.

BY C. S. MIXTER OF WASHINGTON, D.C.

IT is frequently asserted that the colored population of the United States is increasing more rapidly now than it did prior to 1861. The large apparent increase shown by a comparison of the census-returns of 1880 with those of 1870 seems to justify this opinion; but the results of investigations made by the superintendent of census in South Carolina and Mississippi show that the census in 1870 was seriously defective in this respect, while that of 1880 was very full and complete. The accompanying statistical table presents the returns of these people according to each U. S. census from 1840 to 1880, and gives the numbers reported from the South in detail. These results seem to indicate that they are not increasing as rapidly as formerly. The burden of supporting their minor children, and their disregard of the rules of health, seem to furnish additional reasons for thinking that their future rate of increase will be less than it has been heretofore.

Resided in	1880.	1870.	1860.	1850.	1840.
Alabama	600,103	475,510	437,770	345,109	255,571
Arkansas	210,666	122,269	111,259	47,708	20,400
Delaware	26,442	22,794	21,627	20,363	19,524
Dist. of Columbia .	59,596	43,404	14,316	13,746	13,055
Florida	126,690	91,689	62,667	40,242	26,534
Georgia	725,133	545,142	465,698	384,613	283,697
Kentucky	271,451	222,210	236,167	220,992	189,475
Louisiana	483,655	364,210	350,373	262,271	193,954
Maryland	210,230	175,391	171,131	165,091	151,815
Mississippi . . .	650,391	444,201	437,404	310,808	196,577
Missouri	145,850	118,071	118,503	90,040	59,814
North Carolina . .	531,277	391,650	361,522	316,011	268.249
South Carolina . .	604,332	415,814	412,320	393,944	335,314
Tennessee . . .	403,151	322,331	283,019	245,881	188,583
Texas	393,383	253,415	182,921	58,538	-
Virginia	631,616	512,841	527,763	526,861	498,829
West Virginia . .	25,886	17,980	21,144	-	-
Other States . . .	481,540	341,127	226,219	196,570	171,857
Total U. S. . .	6,580,793	4,880,009	4,441,830	3,638,808	2,873,648

Oyster-farming in Connecticut waters.

BY H. C. HOVEY OF NEW HAVEN, CONN.

AN explanation of the difference between seed oysters and those fit for market gave the author occasion to mention that 'saddle rock' oysters in their best edible condition were six or seven years old. A history of Connecticut experience and legislation in relation to oysters was given in detail. There are now 325,000 acres of disposable space for oyster-beds, and 100,000 are occupied. The area of the natural beds is only 6,000 acres, and this furnishes the seed for new beginners. The present expansion of oyster-farming is due to the use of steam-power in gathering the harvest.

The first thing done on an oyster-farm is to stake it out into sections, and then the bottom is examined. The next step is to scatter oyster shells over the farm, and the oyster spawn is scattered. After this, in some muddy localities, small trees, mainly birch, are thrust into the water, in a standing position; and the young oysters set on these trees. The spawn is cast out from June until November, and for a few days the young oysters swim everywhere they please, leading a happy life for a brief period. Shelling begins about June 15, and ends about Aug. 15. When the oysters fill the trees, the latter are pulled up and cleaned off. From one acre of bushes, 1,000 bushels of oysters have been gathered in one year. The oysters set on anything which is clean. They had been found on old boots, old wrecks, and a pair were found on an old padlock. Oyster-farming was not profitable every year; one firm having lost $20,000 by the ravages of the star-fish in one bed, and another firm $100,000 in two years from the same cause. Oysters were formerly imported, but are now exported in immense quantities.

The German carp, and its introduction into the United States.

BY C. W. SMILEY OF WASHINGTON, D. C.

The United States fish-commission, he said, had some years ago imported from Germany thirty or forty pairs of this fish. They were placed in breeding-ponds in Washington, and have increased many-fold, the number spawned this year being 400,000. The carp is naturally a warm-water fish, and in the waters of the southern states grows with astonishing rapidity, and to great size. They will also do well in the cold water of the north, even in Minnesota. Nearly every state and county in the United States has a fish-commission, and they are all propagating carp. It has also been taken up as a private speculation, and carp are sold for breeding-purposes as high as $5 per pair.

The carp roots about in the mud for aliment, and much resembles poultry in its manner of getting food. Carp aged three years are often found to weigh twelve to fifteen pounds, and a gain in weight of four pounds has been observed in a carp in one year. The carp is sluggish; while trout, bass, and other lively fish frisk about, and do not fatten so fast as the carp. Experiments have shown that female carp spawn at the age of one year in southern waters, at two years in colder waters, and in the extreme northern waters of the United States at three years. Other fish, turtles, muskrats, snakes, and even birds, eat young carp. A bird shot in Washington recently had in its stomach the heads of seventy-nine young carp. The U.S. fish-commissioner recently sent out requests for information about carp experimented with in this country; most of the replies placing the carp on an equality with trout, bass, and shad as a food fish, while a few classed them with pike, and a very few said they had a muddy taste. The carp is the best pond fish yet known, and in a very small pond will thrive well, so that families may easily have their own fish-garden if they have enough water to make a permanent pond. The carp is a very hardy fish for shipment, requiring little water to keep alive in. The U.S. fish-commissioner is giving away carp, sending them by express to any point, the receiver paying express charges. The fish will thrive on table-refuse and almost any thing edible. Carp can be kept in winter in a tub in the cellar, the water requiring to be kept fresh. Care should be taken to keep poisonous substances out of carp-ponds, and too much food should not be thrown in. In cooking carp, thorough cleansing is needed; and frying should be done in hot pans and hot grease.

As to the economics of this subject, Mr. Smiley said that fish-culture was more and more becoming a part of the farmer's occupation, and thought that, not very long in the future, most of the farmers of the country would have little fish-ponds in their dooryards, both as a method of obtaining food and as an ornament to the homestead.

Cable-cars for city passenger traffic.

BY E. T. COX OF NEW HARMONY, IND.

Professor Cox, though devoted to geology, has always taken a kindly interest in schemes for industrial advancement. In the present paper he describes the success of the cable system as a substitute for horse-cars; and urges its general adoption, on the ground of its convenience and comfort to humanity, as well as the diminution of suffering to the horse. Some of the collateral statistics presented in the paper are interesting; e.g., the figures given by Mr. Moody Merrill, chairman of the horse-car railroad convention held at Boston last March: "There are in the United States and Canada 415 street-railways, giving employment to about 85,000 men, 18,000 cars, and 100,000 horses in daily use. These horses consume 150,000 tons of hay, and 111,000,000 bushels of grain. 3,000 miles of track represent an invested capital of $150,-000,000. The number of passengers annually carried is 1,212,460,000. In the city of New York there are 110 miles of horse-railway, and 11,866 horses are used to operate them. The horses, together with their harness, expensive lands and stables, feed and grains, make the operating expenses, by including interest, $5,104,596.79 per annum. The average life of the street-car horse in New York is less than three years."

The paper quotes an opinion of Gen. W. Sewell of New Jersey, a practical railroad engineer, who prophesies that, within ten years, the cable system will supersede horse-cars on every considerable street line. The great advantage of the system is its applicability to very steep grades. The paper states, in respect to the most vital question to capitalists, that the cost of the plant in the cable system is shown to be about $70,000 per mile of roadway. We have heard it recently stated, in other quarters, at $120,000; but perhaps one estimate applies to single and the other to double tracks. This makes it, at best, somewhat expensive as an experiment; and that is the light in which it is regarded by many horse-railroad managers at present.

Improved method of spraying trees for protection against insects.

BY C. V. RILEY OF WASHINGTON, D.C.

THE paper gave a summary of results obtained from experiments made during the past two years at the U. S. department of agriculture. An ordinary barrel is used as a reservoir, in which is inserted a force-pump with automatic stirrer. A long rubber hose extends from the pump, and is attached to the spraying apparatus. The nozzle has been called the cyclone or eddy nozzle; its action carries out new principles of spraying. It is a shallow, circular, metal chamber, with two flat sides, in the centre of one of which is a small circular outlet. The fluid is forced into this chamber tangentially, producing rapid rotation, and a spray which is easily regulated from a mist scarcely visible to a strong shower. This nozzle is adjusted to the end of a bamboo rod (of varying length, according to requirement), through which the rubber hose has been passed; or several nozzles may be attached, in different positions, to the sides of a stiff metal tube, sufficiently slender to be handled by the operator, and thrust among the branches of the tree. By these means, trees from twenty to thirty feet high can be rapidly sprayed without the use of a ladder. The substances used are either London purple, one-half pound, and flour, one pound, in from forty to fifty gallons of water; or Paris green, one pound, to the same amount of flour and water; or petroleum emulsions made as Professor Riley indicated at the last meeting of the association.

Enhancement of values in agriculture by reason of non-agricultural population.

BY J. R. DODGE OF WASHINGTON, D.C.

THE paper begins by showing that national industry is prosperous in proportion to its diversity. The productions of agriculture would be unsalable if all the people were agricultural producers. A civilized nation, with the smallest proportion of non-agricultural workers in it, will be low in the scale of prosperity: with the largest proportion of non-agriculturists consistent with proper food-supply, the nation will be most prosperous. To a great extent, this is true also of the subdivisions of this country. It may be illustrated by the statistics of geographical sections that embrace groups of states, or by comparison of individual states. The author is even prepared to show, that, in a partly agricultural community, the increased employment of labor in industries that are non-agricultural stimulates improvement, compels higher culture, and makes the products of land, and the land itself, more valuable. Such is the theory. In support of it, the author adduces striking facts, obtained by compilation from U.S. census returns of 1880.

The states and territories are grouped for this comparison in four classes, which are thus designated: first class, having less than 30 per cent of agricultural workers; second, having over 30 and less than 50 per cent; third, having 50 and less than 70 per cent; fourth, having over 70 per cent, *i.e.*, being almost exclusively agricultural states.

Classes.	No. of states and territories.	Acres.	Value.	Value per acre.	Per cent of workers in agriculture.
First class . .	15	77,250,742	$2,985,641,197	$40.91	16.59
Second class .	13	112,321,257	3,430,915,767	22 21	40.12
Third class .	13	237,873,040	3,218,108,970	13.03	58 85
Fourth class .	6	108,636,796	562,430,842	5.28	77.46

In the first class are Massachusetts, Connecticut, New York, New Jersey, and Pennsylvania in the east, and some of the mining states and territories of the west, diverse in many points, yet alike in the fact of a large non-agricultural population. This class has only one-sixth of the population in agriculture. The fourth class consists of North and South Carolina, Georgia, Alabama, and Mississippi. It has nearly four-fifths engaged in agriculture, on lands worth only an average of $5.28 per acre. The states having only two-fifths in agriculture have farm-lands valued at $22.21 per acre, while those having nearly three-fifths in agriculture have lands valued at $13.03. These figures speak for themselves, and scarcely need comment from the author.

When individual states are compared, the results are equally marked. The author compares pairs of states, — Virginia and Pennsylvania, Kentucky and Ohio, Iowa and Illinois, — as follows (for convenience we place these comparisons in tabular form): —

Items of comparison.	Virginia.	Pennsylvania.	Kentucky.	Ohio.	Iowa.	Illinois.
Per cent of agricultural workers	51.41	20.68	61.67	39.97	57.46	43.65
Value of farm lands per acre	$10.89	$49.30	$13.92	$45.97	$22.92	$31.87
Wages of agricultural laborers per annum .	180.00	431.00	199.00	394.00	[1]	467.00

Similar computations give figures for the State of New York not widely different from those for Pennsylvania. The average value of farm-lands per acre in New Jersey is greater than in any other state, viz., $65.16: this is owing to a position between two great city markets, with proximity and easy access to both. Her percentage of agricultural workers is only 14.92; their average annual wages are $501. It will be seen that the wages of agricultural labor are subject to the same law. If computed for the first table in this paper, the wages per month of the agricultural

[1] The annual wages of agricultural labor in Minnesota are $376.

laborer would be found, for the first class of states, fully $25; for the second, nearly $25; for the third, less than $20; for the fourth, about $13.50.

An application of the same test to the value of annual production for each man engaged in agriculture brings equally interesting results in the following table: —

Classes.	No. engaged in agriculture.	Value of products of agriculture.	Value per capita.	Per cent of workers in agriculture.
First class . .	1,060,681	$484,780,797	$457	16.51
Second class .	1,566,875	616,850,959	394	40.12
Third class . .	3,017,971	786,681,420	261	58.85
Fourth class .	2,024,966	325,099,388	161	77.46

The states with less than 30 per cent in farm-labor realize nearly three times as much per man as those which have over 70 per cent in farm-work. In other words, one man in the first class realizes as much as the three men who are competing with each other, having little outlet for surplus production. Three brothers in Alabama, laboring through the year, get as much for their aggregate produce as one farmer receives in Pennsylvania, simply because that farmer has a brother engaged in manufacture and another in mining. It is because in one case there is a market for one product only, thousands of miles away: in the other, there are markets at every door.

It appears evident that the proportion between agricultural and non-agricultural population is a measure of the values of the land, of the production, and of the labor of the farm. These values are rapidly enhanced by the increase of non-agriculturists. This is the lesson of the most authentic statistics of our own and of other countries.

A new system for the treatment of sewer-gas.

BY T. E. JEFFERSON, HUDSON, WIS.

In this paper, which was well illustrated by diagrams, special reference was made to a series of important inventions which of late have attracted much attention both in this country and Europe. This system chiefly consists in making sewers approximately air-tight by sealing the sewer inlets so as to admit sewage, but exclude the air; making pipe connections between sewers and buildings, and different heating-apparatus arranged to admit the in-flow of atmosphere and the products of combustion into the sewer, and, at the same time, prevent the back-flow of gas; when by the connection of a powerful suction apparatus with the sewer, near its outlet, the removal of sewer-gas and smoke from furnaces and fires, and the thorough ventilation of buildings, is positively effected and regulated as desired.

By employing mechanical force for creating draught for fires, the large percentage of heat heretofore required for this purpose is retained, effecting a corresponding saving in the consumption of fuel.

The main portion of these important discoveries, including the removal of sewer-gas, and the positive means of ventilating buildings and carrying the vitiated atmosphere and poisonous vapors away from contact with the inhabitants, was recently made by Hon. John Comstock of Hudson, Wis., and first introduced in one of the districts of the city of Paris, France, during the present year, where its great utility and practical success are fully demonstrated.

List of other papers.

The following papers were also read in this section: Building associations, by *Edgar Frisby*; and Health foods, by *T. S. Haight*.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Hyperelliptic functions. — M. E. Wiltheiss starts out from a memoir of Prof. Kronecker's which appeared in the *Monatsberichte* of the Berlin academy for the year 1866, in which a method was developed for obtaining the parameters τ_{ik} of those theta-functions, which, for a certain definite transformation, remain unaltered. Prof. Kronecker started out from a purely algebraical stand-point, and solved the equations which connect the original and the transformed parameters τ_{ik} and τ'_{ik}. Corresponding to the transformation of the theta-functions, there is a transformation referring to the integrals belonging to these functions. Noting this fact, the author of the present paper has arrived at these singular values of the τ_{ik} in another manner, and his results bring into evidence a certain property which is analogous to the complex multiplication of elliptic functions. The author confines his attention solely to the theta-functions of two variables. — (*Math. ann.*, xxi.) T. C. [214

Curvature of surfaces. — M. Rud. Sturm has given here a very interesting theorem analogous to Gauss' well-known theorem concerning the measure of curvature at a point on a surface. Gauss' theorem, stated briefly, is, that if a curve p enclosing an area F is drawn around a point P of a surface, and if a corresponding curve p' enclosing an area F' is traced out on a sphere of radius unity by the extremities of radii drawn parallel to the normals to the given surface at each point of p, then the limit value of the ratios of F' and F will be equal to the inverse product of the radii of curvature R_1, R_2, of the given surface in the point P. M. Sturm's theorem is, that if the curve p is cut out of the given surface by a sphere whose centre is at P, then the mean curvature, viz., $\frac{1}{2}\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$, is equal to the limit value of the ratios of the two perimeters p and p'. — (*Math. ann.*, xxi.) T. C. [215

ENGINEERING.

Pressure on valves. — Professor S. W. Robinson presented to the American society of mechanical engineers, at its meeting in New York, November, 1882, a paper on the theoretical and the experimental determinations of the mean pressure on steam-valves exposed to pressure both above and below. He finds that a line can be determined, circumscribing an area which he calls the equilibrium area of the valve. This area being multiplied by the maximum pressure gives the total mean pressure acting to hold the valve to its seat. The extent of this area is determined by experiment; and a theory of the case is constructed, which is given at length, with the practical formulas derived by means of it for use in designing. — (*Van Nostrand's mag.*, July.) R. H. T. [216

The performance of the Worthington pumping-engine. — Messrs. Shedd and Ward present to the water-commissioners of the city of Buffalo a report upon the performance of a Worthington pumping-engine, recently built for the city. The delivery was 28.8% greater than was demanded under the contract with the makers, amounting to above 19,000,000 gallons per day; and the 'duty' was something above 70,000,000 pounds of water raised one foot high per thousand pounds of steam used. This was above the duty demanded by the city. — (*Ibid.*) R. H. T. [217

CHEMISTRY.

(*Organic.*)

Reconversion of nitro-glycerine into glycerine. — Great difficulty having been experienced in destroying the dynamite recently captured in England, Prof. C. L. Bloxam has tried several methods for decomposing its nitro-glycerine constituent. 1. Nitro-glycerine was shaken with methylated alcohol, and the solution was mixed with an alcoholic solution of KHS. Considerable rise in temperature resulted, the liquid became red, a large quantity of sulphur separated, and the nitro-glycerine was entirely decomposed. 2. Nitro-glycerine was shaken with a strong aqueous solution of commercial K_2S. The same changes were observed as in 1; but the rise in temperature was not so great, and the liquid became opaque very suddenly when the decomposition was completed. 3. The ordinary yellow solution of ammonium sulphide was mixed with the nitro-glycerine, and the mixture evaporated to dryness on the steam-bath, when bubbles of gas were evolved, due to the decomposition of the ammonium nitrite. The pasty mass was treated with alcohol to extract the glycerine. 4. Calcium sulphide, made by boiling flowers of sulphur with slaked lime, was used. Reduction took place as above, but more slowly, and more agitation was required. This last is the cheapest process. — (*Chem. news*, April 13.)

The reducing action of alkaline sulphides on nitro-glycerine was pointed out some time since, and A. H. Elliott, F.C.S., showed in the *School of mines quarterly*, Sept. 15, 1882, that the method admitted of quantitative application. — C. E. M. [218

METALLURGY.

Water-gas as a fuel. — Mr. W. A. Goodyear believes that the fuel of the future in cities, for all domestic as well as for most manufacturing and metallurgical purposes, will be gas of some kind. The ease and cheapness of its distribution, the cleanliness and economy of its use, will, in his opinion, cause at no distant day a revolution in the present use of fuel. As a contribution to that end, he describes an apparatus of his own devising for the manufacture of water-gas, by means of which, he claims, this gas can be made in any desired quantity; and, while leaving a handsome profit to the manufacturers, it can be supplied at a cost that will render its general use more economical than that of any kind of solid fuel. — (*Trans. Amer. inst. min. eng., Boston meeting.*) M. E. W. [219

The recovery of the volatile constituents of coal. — The attention at present paid to the utilization of products heretofore wasted is well illustrated in an account of the Jameson process of coking coal, given before the London society of arts, April 26. The coking-ovens of England are estimated to have a capacity of some 20,000,000 tons a year; and only a slight and inexpensive alteration in the plant would, it is said, recover oil and ammonia to the value of $16,000,000, and good heating-gas to the value of $12,500,000. From the experiments of Sir J. B. Lawes, it has been estimated, that, if all the ammonia from all the raw coal burned in England were utilized in agriculture, 250,000,000 dollars' worth of bread-stuff would be added to the yearly produce. The use of raw coal is characterized as a relic of barbarism. — (*Iron*, May 4.) R. H. R. [220

GEOLOGY.

Stratified drift in Delaware. — F. D. Chester describes the relations of the gneissic rocks of Delaware, with their rolling, hilly, and local soils, to the unconformably overlying cretaceous clays extending to the south-east, with stratified gravels derived from the gneiss. These gravels and similarly derived deposits extend even over the top of Polly Drummond's hill, the highest land in the state, two hundred and fifty feet above the cretaceous plain, and three hundred and thirty feet above the sea. Large dolerite bowlders of undetermined origin, sometimes twenty-five feet in circumference, lie on this hill; and a little farther south there are two hills of unstratified detritus and bowlders, which are thought to have been dropped from ice floating in the sea, that deposited the stratified gravels during the submergence of the Champlain period. As the highest point in Delaware was then covered, this measure gives a minimum value of three hundred and thirty feet for the submergence. — (*Amer. journ. sc.*, xxv. 1883, 436.) W. M. D. [221

Meteorites.

Concretions in meteoric iron. — Professor J. Lawrence Smith gives a connected statement regarding the concretions found from time to time in the interior of various meteoric irons. Six kinds of simple nodules occur, composed respectively of pyrrhotite (troilite), schreibersite, graphite, daubréelite, chromite, and lawrencite. Others consist of several minerals aggregated together. Smith holds, from the study of these concretions, that the containing 'iron was at one time in a plastic state from the effect of heat.' —(*Amer. journ. sc.*, June.) M. E. W. [222

MINERALOGY.

Scovillite. — Under this name, Messrs. G. J. Brush and S. L. Penfield have described a new phosphate from the Scoville ore-bed, Salisbury, Conn. It occurs as a thin crust of a pinkish or brownish color, coating iron and manganese ores. Hardness, 3.5; specific gravity, 4. Before the blowpipe the mineral is infusible, and, with borax and salt of phosphorus, gives beautiful rose-colored beads (didymium) in both oxidizing and reducing flames. It is readily soluble in dilute acids. Chemical analysis yielded P_2O_5 (24.94). $(Y,Er)_2O_3$ (8.51). $(La,Di)_2O_3$ (55.17). Fe_2O_3 (0.25). H_2O (7.37). CO_2 (3.59) = 99.83 %. The presence of carbon di-oxide is regarded as due to an admixture of lanthanite, — $(La,Di)_2$ $(CO_3)_3$ $9H_2O$; and, deducting the constituents corresponding to the above formula, there is left 82.79 % of a phosphate, which, calculated up to 100 %, gives P_2O_5 (30.12). $(Y,Er)_2O_3$ (10.28). $(La.Di)_2O_3$ (55.75). Fe_2O_3 (0.30). H_2O (3.57) = 100 %. This corresponds closely with the formula $R_2(PO_4)_2$ H_2O, where R = (Y, Er, La, and Di). The new mineral is therefore a normal phosphate of the above metals, plus one molecule of water. — (*Amer. journ. sc.*, June.) S. L. P. [223

Ullmannite. — Crystals of this mineral from Montenarba, Sardinia, have been crystallographically investigated by C. Klein. The crystals were embedded in calcite, and were obtained by dissolving the calcite in dilute acetic acid: they were of cubical habit, possessed a perfect cubical cleavage, and showed on the cubic faces the striations so common in pyrite, and characteristic of the parallel or pyritohedral hemihedrons. Besides the cube, the faces of the rhombic dodecahedron and pentagonal dodecahedron, $\pi \infty O_2$, were observed. The chemical analysis was made by P. Jannasch, and yielded S (14.02). Sb (57.43). As (trace). Ni (27.82). Co (0.65). Fe (0.03) = 99.95 %, corresponding closely with the formula Ni Sb S. Gravity, 6.84. The mineral is therefore closely related to pyrite, crystallizing like it in parallel hemihedrons, and having an analogous composition in that the nickel and antimony are isomorphous with iron and sulphur. — (*Jahrb. min.*, 1883, 180.) S. L. P. [224

GEOGRAPHY.

(*Africa.*)

French missionary-work in eastern Africa. — The French missionaries sent from Algeria have successfully established a station at Tabora in charge of Père Hautcoeur. Their missions at Ujiji and Usanzé are progressing favorably. That at Uganda, owing chiefly to the petty persecution experienced from king M'tesa, has been abandoned, and the party have taken refuge on the southern shores of Lake Tanganyika. Six new missionaries have been despatched from Algiers to re-enforce the staff at stations in Central Africa. The station at M'rogoro, less than six months old, already presents the aspect of civilization, stone buildings replacing thatched huts; and the adjacent land, until lately covered with forests and jungle, has been cleared, and planted with coffee-bushes, which appear likely to succeed. Other establishments are equally flourishing. — (*Comptes rendus soc. géogr.*, no. 11.) W. H. D. [225

BOTANY.

Protogyny of grasses. — Bailey gives as an example, Spartina juncea. — (*Bull. Torrey club, July.*) W. T. [226

Pollination of prickly pear. — Dr. Kunzé sees, in the irritable stamens of Opuntia vulgaris, a provision for securing close fertilization by insect aid. In fair weather each flower opens on two successive days. Hive-bees, flies, and humble-bees were seen to visit the flowers for nectar, in obtaining which they grasp clusters of stamens, which, when released, fly up against the pistil, from which they slowly recede to their former position. Although the legs of the insects were covered with masses of pollen after visiting a flower, they were not seen to creep over the stigmas: *ergo*, the pollen grains are supposed to be thrown between the stigmas after the sudden movement following the retreat of an insect. It is hardly necessary to add, however, that crossing is well effected by the insects in question, the motion of the stamens insuring a thorough dusting of their bodies with pollen. — (*Bull. Torrey club, July.*) W. T. [227

Mimicry. — Bailey notes the resemblance of a spider to the involucral scales of the swamp thistle, on which it lies in wait for insects which visit the flowers. — (*Bot. gazette, Aug.*) W. T. [228

ZOÖLOGY.

Mollusks.

Pleurotomidae of Senegambia. — Baron von Maltzan reviews the Pleurotomidae of this region, especially of the Island of Goree. He obtained thirty-six species and varieties, of which about one-third are new. Only four were known to Adanson, who first monographed this fauna. About fifteen per cent are European forms, which are smaller and rarer than those of the same species in the Mediterranean. — (*Jahrb. mal. ges.*, vii. ii.) W. H. D. [229

Mollusca of the Caucasus. — Böttger offers an important paper on the land-shells of the Caucasus, supplementary to others printed in preceding years. Rich material has been brought together by Gen. Komaroff and Hans Leder. The Limacidae afford several new forms: the new section Gigantolamax is proposed under Amalia, and Paralimax under Limax. A new genus of Testacellidae, Selenochlamys, is proposed for a form resembling Daudebardia externally, but without an internal shell, and with the respiratory orifice at the right anterior part of the very small clypeus. No known mollusk closely resembles this remarkable slug, which was found near Kutais. A large number of new species and varieties are described. — (*Jahrb. mal. ges.*, vii. ii.) W. H. D. [230

Monograph of Ringicula. — L. Morlet has published a second supplement to his valuable monograph of Ringicula, in which four new recent and as many new fossil forms are made known, and a synopsis, after Seguenza, of the tertiary Italian species, is added. — (*Journ. de conchyl.*, xxii. 3.) W. H. D. [231

Worms.

New worm with remarkable nervous system. — The Willem Barents on her third voyage captured a worm, which A. A. W. Hubrecht describes under the name of Pseudonematon nervosum. He gives a general account of its structure, and promises a fuller monograph. The animal is about sixty-five millimetres long, one and three-quarters millimetres thick, tapering behind. The digestive tract runs straight through from end to end. On the ventral side, about forty-five millimetres from the head, is a disk, probably a sucker. No traces of sexual, excretory, or sensory organs were found. The epidermis is thin. The muscles form three layers, — a thick external longitudinal, a middle transverse or circular, and an internal longitudinal layer, — variously developed in different parts of the body. The nervous system is very remarkable: it forms a continuous layer completely around the body, and lies immediately inside the layer of circular muscular fibres. It consists, 1°, of a fine network of delicate filaments, appearing as if felted, barely tinged by the staining reagents; and, 2°, of scattered nuclei belonging partly to connective tissue, partly to ganglion-cells. The layer forms a continuous tube from the head, where there is no ganglionic enlargement, back through the body to the caudal region, where the layer is present dorsally only.

Hubrecht further discusses the phylogeny of the nervous system in continuation of his previous paper (*Quart. journ. micr. sc.*, xx. 431). He points out, that, 1°, in its lowest form (Medusae), the nervous system is diffuse, and there are no nerve-fibres properly so called; 2°, in a little more advanced stage it tends to form a layer spread out under and parallel with the ectoderm; the general histological character is the same as under 1°, — a felted network of fine fibrillae, which spring from the ganglion-cells (Actiniae, Psuedonematon); 3°, the diffuse layer is still present, but certain tracts are more developed, making the primitive nerve-cords (Chaetognathi, Chiton, etc.); 4°, the diffuse part is gradually lost, and the cords are retained. These conclusions are confirmed by citations from numerous recent researches. Dr. Hubrecht has, we think, successfully established two very important generalizations, — first, that in the lower animals there prevails a uniform type of nervous tissue, ganglion-cell and nerve-fibre being incompletely differentiated, and the nerve-fibres being in the form of a network; secondly, that the nerves were developed by concentration of the diffuse tissue along certain pathways. His paper is certainly one of much value and originality. Systematically the position of Pseudonematon is uncertain, but it probably belongs somewhere near the nematods and plathelminths. — (*Verh. acad. wetensch. Amst.*, xxii. 3d art.) C. S. M. [232

VERTEBRATES.

Development of the diaphragm and pericardium. — Our knowledge of the changes which lead to the partitioning-off of the anterior end of the body-cavity in vertebrates to form the pericardial and pleural cavities has heretofore remained obscure. Uskow has investigated the subject under Waldeyer's direction, at Strassburg, and publishes an important memoir. The essay opens with a review of the previous literature. The research was carried out principally on rabbits, but also extended to other mammalia, and classes of vertebrates. At nine days (in rabbit embryos) the omphalo-mesaraic veins enter the body from the sides, along the lower wall of the body-cavity, into which they bulge up. The part of the body-cavity in front is cylindrical; behind, fissure-like. The two cylindrical halves meet anteriorly, and unite below the heart, forming the primitive pericardial division of the coelom. The posterior wall of this cavity is pierced by the sinus venosus, and receives the name of septum transversum: it is a thin membrane, which separates the pericardial space from the fore-gut of the embryo. In the next stage, the pericardial space has enlarged, the most important effect of which is to drive the septum transversum backwards until it lies together with the omphalo-mesaraic veins, so producing the membrane which supports the great veins, and divides off the ventral portion of the pericardial space from the dorsal portion and the general body-cavity, or paired coelom. This membrane then forms part of the wall of the pericardial cavity; but it also forms the primitive diaphragm, the dorsal portion of the original pericardial space becoming, in conjunction with the anterior end of the coelom, the pleural cavity.

The pericardial wall consists, according to its development, of three parts: 1°. part of the original wall of the coelom (this includes that portion which remains permanently attached in mammals to the anterior thoracic wall); 2°. the septum transversum, which becomes the pleuro-pericardiac membrane; 3°. the principal part derived from the body-wall, its separation being consequent upon the enlargement of the pleural cavities. The part from the septum is originally continuous with the diaphragm.

The diaphragm is at first a connective tissue structure. The muscle grows in later from the dorsal side, appearing first in embryos (rabbits) of nine millimetres length. It probably is derived from the muscle plates, but that was not determined with certainty. The primitive diaphragm arises in its ventral part from a papillary growth of the septum transversum; in its dorsal part, laterally from the tissue carrying the large omphalo-mesaraic veins; medianly, from the outgrowth of the septum transversum known as the massa transversa.

From the comparative study of other types, the following grades of development of the diaphragm were ascertained. 1. The ventral and dorsal portions of the diaphragm are completely developed: they completely divide the coelom, and have muscles. The pericardium, except two thin lamellae, is entirely separated from the diaphragm (rabbit). 2. Same as 1, save that a part of the diaphragm remains united with the pericardium (man). 3. Same as 2, but the diaphragm contains no muscles, and its ventral part is completely fused with the pericardium (hen). 4. Same as 3, but the dorsal part is not completely developed, remaining in a primitive condition (lizard) or in an early stage (frog). Here might properly be reckoned certain imperfect developments in man. 5. Same as 4, but the diaphragm, or its ventral part, forms a united whole with the pericardium, remaining at the stage of the septum transversum (Myxinoids, — Ammocoetes). 6. The teleosts stand apart, in that, although, as seen in the salmon, there is a certain separation of the diaphragm from the pericardium, even more than in birds, yet the dorsal portion of the diaphragm is completely wanting.

The paper contains numerous details. The author's nomenclature is confusing, and we have found it very difficult to follow his account. — (*Arch. mikr. anat.*, xxii. 143.) C. S. M. [233

ANTHROPOLOGY.

Mutilations of the teeth. — Ethnographers who have minutely described mutilations of the teeth in other parts of the world have said nothing of a similar practice among the natives of the two Americas. The practice is not common in the western world; and it is a little singular that people who deform to an extraordinary degree their lips, noses, cheeks, and ears, respect the integrity of their teeth. The historians of this practice overlook the abrasions noticed by Vancouver among the Indians of Trinidad Bay, and by Petitot among the Tchiglits at the mouth of the Mackenzie and of the Anderson. Finally, no notice is taken of dental mutilations formerly in use in Mexico and Yucatan, upon which Sahagun, Landa, and Mota Padilla have furnished information. M. Hamy has gathered from the last-named writers their allusions to these subjects, and prepared an illustrated monograph. The drawings indicate both filing and perforations. — (*Bull. soc. anthrop. Paris*, v. 879.) J. W. P. [234

Imperial Chinese tombs. — Among the mountains east of Peking are the imperial tombs. The Great Wall forms the northern boundary of an enclosure five miles square. Besides this, a wide tract outside the boundary-wall belongs to the mausolea, and is forbidden ground, wherein man is not permitted to build dwellings or to bury his dead. Shun-chih (1644–62) and four of his successors sleep here, with the heavens, the hills, and the streams around them. The earlier Manchu princes are buried at Movkden. The tombs are all alike in essential features, built on a southern slope, with a stream in front. In approaching the tomb, the explorer passes first two lofty stone pillars, that serve as a gateway to figures of men and animals in pairs, facing one another on opposite sides. An ornamental archway opens upon a curved marble bridge of several arches, with finely carved balustrade. After crossing the stream, the traveller passes guard-houses and the sacrificial hall on the right and left, and comes upon a small building, in the centre of which stands, supported upon the back of a huge marble tortoise, the memorial tablet, on which is written an account of the deeds of the departed. Halls of entertainment flank this building; and farther on in a direct line are the chapel of the dead, the bright pavilion, and, last of all, the earth-palace, or tumulus, within which the coffin lies. When the body is laid in this earth-palace, the door is shut. Behind the door, inside, is a round hole in the stone floor; and, when the door is shut, a large ball of stone follows it, and, falling into the hole, prevents the stone door ever opening again. The emperor is then said 'to be at peace forevermore.' Mr. F. S. A. Bourne, who gives the information above quoted, entered this enclosure with great difficulty. A minute account of the appearance and function of the two rows of sphinx-like figures adds much interest to the author's narrative. The mausoleum prepared for the present empress's regent is just completed, and cost about £1,500,000. — (*Proc. roy. geogr. soc.*, v. 23.) J. W. P. [235

EARLY INSTITUTIONS.

Malagasy place-names. — We have a long article upon local names in Madagascar by the Rev. James Sibree, jun. The object of the writer is to show how the names of places illustrate the mental habits of the people and their powers of observation. Many names of villages include Malagasy equivalents for the Anglo-Saxon words *tun*, *ham*, *burgh*. Personal names are very common. Villages are named after distinguished chiefs The article will interest some of our readers. — (*Journ. roy. Asiat. soc.*, April, 1883.) D. W. R. [236

Chinese laws and customs. — An article upon this subject by E. H. Parker appeared in the *China review*, viii. 67. Now we have another by Christopher Gardner. The two writers are of one mind upon most points. It is only upon a few matters of detail that they differ. Mr. Gardner tells us that the laws and customs of China have been very little changed since the seventh century. Chinese law, we are told, cannot be 'squared' with the theory of Bentham and Austin, which resolves all laws into commands imposed by a lawgiver. It is based upon public sentiment and opinion, and upon previously existing custom. It 'follows the instincts of the people.' Then we are told that the tribe has been derived from the family, not the family from the tribe. Exogamy has in China prevailed over endogamy. As for the land, it is held by single families (house communities), or by groups of families (village communities). It is a pity that the writer does not describe the house community and village community more fully, and in more exact language. The article is interesting. — (*Journ. roy. Asiat. soc.*, April, 1883.) D. W. R. [237

NOTES AND NEWS.

WITH this number our report of the meeting of the American association is completed. No session of section G was held, and no vice-presidential addresses delivered in sections C, D, or G. In our next number we shall print in full the promised papers of Messrs. Carhart and Dana. At some future time we may also take occasion to refer more particularly to the report of the committee upon the removal of duties on imported text-books and the discussion of the same, of which we have a full account. Few other committees besides this, and those already announced, made any reports; and the several committees on weights, measures, and coinage, on standard time, on primary meridian and international standard time, and on the records of science, were discontinued, that on standard time in consequence of the favorable action of the railways of the country in the proper direction. The committee on the introduction of science teaching in the public schools, on the registration of deaths, births, and marriages, on stellar charts, and on an international convention of scientific associations, reported progress, and were continued.

A by-law to the constitution was passed, providing that every member should have the privilege of registering the members of his family at meetings of the association (not including men over twenty-one years of age), by paying three dollars for each registration; the person so registered being entitled to all privileges offered members by the local committee. The standing committee also passed a rule that hereafter no paper will be accepted for reading before any of the sections, unless accompanied by such abstract as the writer deems ready for publication.

Sections H and I had, in some respects, a similar experience at Minneapolis. Both were unable to organize until the week of the meeting was half over. To each there came, almost at the very last moment, a paper of unusual interest. In the anthropological section, Miss Babbitt's paper announced the discovery, in Minnesota, of traces of human labor beneath a deposit of twelve or fifteen feet of the material which forms one of the terraces of an ancient river. This seems to be a confirmation of the theory advanced by Dr. Abbott, respecting his similar discoveries in New Jersey, that man existed on this continent during at least a portion of the glacial epoch. There will, of course, be a lively discussion between experts, as to whether these quartz specimens are actual relics of human industry. Thus far, at best, the glacial workman is known only by his chips.

In the section devoted to statistics, Mr. Dodge announced what may perhaps be accounted a discovery in that dry branch of science. He has found that a singular and quite definite relation exists, in large communities, between an excess of non-agricultural over agricultural workers, and an increase of values in the land, products, and wages of agriculture. The figures may soothe the fears of those political economists who from time to time predict national disaster because so few American youths take kindly to farming pursuits. An obvious inference from the statistics is that prosperity comes where industry is diversified. Weapons of argument may thence be drawn by those who believe in a public policy tending to encourage non-agricultural industries.

— The Royal academy of medicine of Turin has unanimously awarded the Riberi prize of 20,000 francs ($4,000) to Prof. Bizzozero for his researches on the 'Physiopathology of blood,' the subject proposed by the academy. The commissioners of award received several essays: those of Wharton Jones, Norris, Hayem, and Bizzozero were considered to deserve special consideration. The last two were assigned the first rank. The most important matter in both of these is the investigation of the third morphological element of the blood (Hayem's haematoblasts). The commissioners, all well-known *savants*, judged that Hayem did not completely demonstrate that the red globules are derived from the haematoblasts. Bizzozero solves the important problem of the origin of the red globules, determines the relation of the haematoblasts to coagulation, and throws new light on the formation of thrombi. His memoir was therefore deemed the more important, and to Bizzozero accordingly the very valuable award has been made.

— The officers of the Cincinnati society of natural history inaugurated about June 1 a course of free lectures on botany. The first was given on June 9, to a company of forty-seven, many of them teachers in the public schools. The lectures have been continued weekly, and the last was given on Aug. 11. The object of the society in the establishment of this course was to get the public generally interested in scientific pursuits; and the success of this, the first attempt of the kind in this city for many years, has been most gratifying. The average attendance has been over thirty, notwithstanding the hot weather, lateness of the season, and the absence from the city of many who would otherwise have attended. The officers hope, in the autumn, to have courses in other branches of science, so that a general interest may be awakened among the citizens, and attention called to the importance of the study.

— News has been received from the French meteorological station at Orange Harbor, Patagonia: all were in good health, and work progressing favorably. The cattle which had been brought from Montevideo had perished, but those from Punta Arenas were flourishing. The surgeon of the party, Dr. Hyades, had made full anthropological investigations of the Fuegians who were settled near the station. Casts of heads and limbs had been secured, and many photographs taken. A collection of utensils, etc., had been brought together, including a large canoe with its entire outfit. He was engaged in studying the language, which appeared to be somewhat different from the vocabularies collected by Darwin nearly half a century ago.

— Professor W. A. Rogers wishes us to state that the relation between the imperial yard and the *mètre des archives* is wrongly given in our abstract of his paper on p. 250. It should have been stated as follows: Imperial yard + 3.37027 inches = *mètre des archives.*

— Matthew Arnold's ingenious argument for the survival of literature, from its relation to conduct, encounters an objection in the apparent effect of scientific pursuits upon the character of his countrymen. When one affirmed of Clerk Maxwell, that "he was free from every taint of the world, the flesh, and the devil," it seemed no exaggeration to those who knew him. Darwin, Balfour, Sir Rowan Hamilton, and H. J. S. Smith, each in his turn was scarcely less endeared by his genial virtues than admired for his lofty powers. None of these was so largely identified with the world, its business temptations, its social allurements, as William Spottiswoode, the late president of the Royal Society; and none left the memory of a purer life, a heart more "full of exercised humanity."

In his funeral sermon, referring to the text, "The world passeth away, and the lust thereof; but he that doeth the will of the Lord abideth forever," the Dean of Westminster Abbey said, "Apart from general considerations of life and death, the words have special reference to that last one of our own time accounted worthy to rest with the illustrious dead within these walls. . . . To his great talents and his profound knowledge were united such graces of character as the most modest unselfishness and the most spotless integrity. He was ever anxious, earnestly and justly, to place before his fellow-men such knowledge as would conduce to their welfare; and so well did he do this work among his countrymen, that it might be doubted whether his philanthropy did not predominate over his love of science."

— M. Pasteur has proved that the burial of diseased animals does not destroy the germs of disease, or obviate the chance of infection to any animals who may afterwards feed on the ground above where the body of the diseased animal was buried. M. Aimé Girard proposes to destroy the germs in the dead bodies of diseased animals by treating the carcasses with cold concentrated sulphuric acid. The destruction of the germs is proved to be complete. Experiments made at St. Gobain show that three hundred and twenty-one kilograms at 60° proof, dissolved in ten days nine sheep, weighing two hundred and four kilograms. The resulting liquid, mixed with four hundred and forty kilograms of coprolites from Ardennes, produced nine hundred and forty kilograms of superphosphate of lime, containing thirty-six per cent of nitrogen. Thus, by a simple process, most dangerous bodies are destroyed, and a valuable fertilizer obtained.

— *Nature* announces that the Lords of the committee of council on education, of England, have, by a recent minute, decided to withdraw the prizes hitherto given to candidates in the science examinations who obtain a first class in the elementary stage of the various subjects of science, substituting certificates of merit, and retaining only the prizes given in the advanced stage. The money hitherto devoted to prizes will be employed in providing thirty-six national scholarships, — twelve each year, — which will be offered in competition to students of the industrial classes, and awarded at the annual examinations of the department. The National scholarship will be tenable, at the option of the holder, either at the Normal school of science, South Kensington, or at the Royal college of science, Dublin, during the course for the associateship, — about three years. The scholar will receive thirty shillings a week during the session of nearly nine months in the year, second-class railway fare to and from London or Dublin, and free admission to the lectures and laboratories. This is a most important step in advance.

— The Rev. Father Émile Fortuné Stanislas Joseph Petitot, well known for his valuable contributions to American linguistics and his extended journeys over the Hudson Bay territory, has received a medal from the Royal geographical society. He is the first Frenchman thus honored since Francis Garnier. He has now retired from mission-work, and will devote himself to study for some years.

— The Delaland-Guerineau prize has for the second time been bestowed by the French academy upon M. Savorgnan de Brazza, of Congo notoriety. The military medal for 'exceptional services' has been given to the sergeant Malamine, a native of Senegal, for his defence of Brazzaville against all comers during the absence of his superior.

— The last number of the bulletin of Nuttal club contains part of Burrows' list of birds from the lower Uruguay, which is sufficiently full to be of value. The critical list of birds in vicinity of Colorado Springs is of great interest. Mr. Allen's valuable list of minor ornithological publications should also be mentioned.

— Mr. E. H. Miller states, in the *American agriculturist*, that wherever the ornamental shrub commonly called Deutzia scabra grows near grape-vines, the rose-bugs prefer the flowers of the Deutzia, and thus the grapes are protected. Grape-growers may therefore cultivate a charming shrub with a double purpose.

— Rev. W. W. Meech recommends, in the *American agriculturist*, judicious salting to prevent the blight which troubles quinces, and burning affected parts to overcome the ravages of the fungus Roestelia aurantiaca.

— The sixth annual report on the birds of Germany in the *Journal für ornithologie* contains many interesting notes on migrations and breeding-dates.

— At a lecture recently given at Mauch Chunk, Penn., by Mr. Charles A. Ashburner, geologist in charge of the anthracite surveys in that state, the lecturer made some general statements in regard to the amount of coal which has been mined, and which still remains in the region, which we copy from the *Mining herald* of Shenandoah. "The total amount of coal produced from the anthracite fields up to Jan. 1, 1883, was 509,333,695 tons. It is hard to realize this amount. To place it in a popular form, it was stated that it would form a solid compact wall of coal (25 cubic feet = 2,240 pounds = 1 ton) 100 feet wide and 100 feet high for a distance of 241 miles, or it would form a similar wall along the railroad between Philadelphia and New York 100 feet wide and 268 feet high. It was estimated that the region originally contained 25,000,000,000 tons. If it be assumed that in the production of 509,333,695 tons an area has been practically exhausted which originally contained 1,500,000,000 tons, there is 94% of the coal originally contained which still remains untouched. In comparing the anthracite region with the bituminous fields of England, the estimated contents of the former is about one-sixth of what the most recent estimates assign to the latter. About the same proportion exists between the annual production of Pennsylvania anthracite and English bituminous. Mr. Ashburner stated the estimates were based upon very general, but at present the most reliable data. The geological-survey estimates have not yet extended beyond the Panther Creek basin, between Mauch Chunk and Tamaqua. It was stated that this basin originally contained 1,032,000,000 tons of coal, — double the amount which has already been shipped from the entire region. An area had been mined over in this basin, up to last January, which originally contained about 92,000,000 tons, so that 91% of the original coal still remains untouched. About 88% of the coal which has been mined from this basin was taken from the mammoth bed."

In a subsequent communication to the same paper, Mr. Ashburner disclaims having made any statements with regard to the exhaustion of the anthracite coal-fields of Pennsylvania, with which he had been credited by various newspapers. He adds, however, that Mr. P. W. Sheafer, who has probably given this subject more careful consideration than any one else, has made a very general statement that the field still contains about 25,000,000,000 tons of coal. Up to Jan. 1, 1883, he had estimated that the total production amounted to 509,333,695 tons. It has been generally thought that but one-third of the coal contained has been consumed as fuel; so that, up to last January, an area had been exhausted which originally contained about 1,500,000,000 tons, 23,500,000,000 tons remaining untouched. If this same proportion of production to original content be applied to that which still remains, about 8,000,000,000 tons would represent the possible future production. According to the mine-inspector's report, there was produced last year 31,281,066 tons. If this production should remain constant for all future time, the field would be exhausted in a little over 250 years. Such a conclusion is quite untenable, for our yearly production is rapidly increasing. In 1870 there was shipped from the region 16,182,191 tons, and in 1880, 23,437,242 tons. The abrupt exhaustion of the coal-fields is a practical impossibility; nor is it reasonable to suppose, that, if on an average for every ton of coal won there are two lost, this will be the practice in future mining. The geological survey has already in its possession many valuable facts to throw light on this subject; but, as it is hoped that the survey will be completed before this question of ultimate exhaustion will become one of practical concern, it would be folly to make any statement as to how long the coal will last.

— M. Daubrée has been examining an interesting meteorite which fell not far from Nogoga, in the province of Entre Rios, Argentine Republic. Chemical analysis proves that the meteorite contains iron, lime, and magnesia; but its most important feature is, that it is said to contain carbon in an organic form, which is chiefly proved by the action of potash in it. M. Daubrée from this is led to hope that he may yet find organic remains in a meteorite.

— In the September *Atlantic*, Bradford Torrey prints some studies in the temperaments of birds, which will interest ornithologists, as they are made from personal observation. The chickadee, goldfinch, brown thrush, towhee, blue-jay, shrike, white-eyed vireo, and chat, and the New-England species of Hylocichlae, are discussed.

— The Florence newspapers announce the acquisition of a skull of Mastodon arvernensis by the Istituto di studii superiori. Professor d'Ancona writes to *La nazione*, that it was found through excavations that were making in pliocene deposits in the neighborhood of Percussina, situated about two hundred metres above the sea, between Siena and Florence.

— In his recent work on cultivated plants, DeCandolle says, "In the history of cultivated plants I have found no indication of communications between the inhabitants of the old and new world anterior to the discovery of America by Columbus. The Gulf Stream has equally been without effect. Between America and Asia, two transportations may have been effected; one by man (the batatas), the other by man or by the sea (cocoa-nut)." Drs. Gray and Trumbull, in commenting on this in the last number of the *American journal of science*, say, "Perhaps the banana should be ranked with the sweet-potato in this regard. And we may merely conjecture that the purslain came to our eastern coast with the Scandinavians or the Basques."

— Ostrich-chicks are hatching out at the ostrich-farm near Anaheim, Cal., at the rate of one a day. When they first come out of the egg, they are about the size of a half-grown duck. They have good appetites, and grow rapidly.

— Means of transportation are rapidly increasing on the borders of countries not within the recognized bounds of civilization. Thus it is announced that the journey from Paris to Algiers will shortly be reduced to thirty-three hours rail and steamer travel, of which only sixteen will be by boat. Hitherto passengers by the Marseilles line, in the regular routine of travel, have spent forty hours on the water alone, beside the railway journey from Paris.

— At the meeting of the French entomological society, held July 11, Mr. E. Lefèvre showed a large solitary ant allied to Ponera, found about Hong Kong, remarkable for the extraordinary development of its mouth parts, and for its power of leaping; being able, when disturbed, to make bounds of twenty to twenty-five centimetres. The statement was confirmed by the experience of earlier observers. As the legs are in no way developed for springing, Mr. Lefèvre was inclined to think that it was accomplished in some way by its buccal organs.

SCIENCE.

FRIDAY, SEPTEMBER 21, 1883.

THE U. S. SIGNAL SERVICE.

II.

It must be said that the annual report would be vastly improved by being made either one thing or the other, or, better, two separate things. At present it is at once a *résumé* of meteorological work done during the year, and a government blue-book. As the former, it falls far short, not of the ideal, but of the possible: it is probably equally deficient considered as the latter. It is certainly desirable that the summarized results of such great labor, comprehending so vast a field, should be published annually in such a form as to be useful to those who are engaged in meteorological study and research, and it ought to be done with reasonable promptness.

The size of the volume might be reduced to at least one-half of what it is at present, and that without material loss. The report proper of the chief signal officer ought to be rewritten; and it does not seem too much to ask that it be prepared afresh every year, and that it should be confined to a statement and discussion of the actual progress made during the year. Expensive reprinting is a luxury that only government offices can afford to indulge in, and it is sometimes carried to an extent that is not only wasteful, but positively objectionable. A large portion of this annual report is made up of a republication of the monthly weather-reviews for the year. These have already been printed and circulated among those to whom they would be useful. Another large part consists of material already printed and circulated as 'Instructions to observers,' and might well be dispensed with here. The 'annual meteorological summary,' occupying about one-fourth of the volume, is susceptible of considerable condensation without loss of value to the student of meteorology. Many of the appendices are made up entirely of matter which is, of itself, not without value, and which may well be kept on file and accessible at the central office, but which is entirely without interest or value to the majority of those into whose hands this report is intended to fall. A much smaller volume, embodying the real meteorological work of the year, with such discussions thereof as could be given, as everybody knows, by persons in the employ of the government at the central office, would be welcomed everywhere, and would be a real boon to students. As at present issued, the report is unmanageable, uninviting, and unsatisfactory.

As already intimated, the report for 1881 contains evidence of some important changes in the organization of the central office, and in the general policy of the service. It seems now to be recognized, that meteorology is, or will be, a *science*, and that it is wisdom on the part of the government to secure the cooperation of scientific men in the work which it has undertaken, as well as to employ an important portion of its own staff in the investigation of meteorological problems, and the carrying-on of special researches. This is a step which, although tardy, will be highly appreciated.

Among the most tangible results thus far may be mentioned the permanent establishment of a 'scientific and study division.' The wisdom of placing this entirely under the control of Professor Abbé, and of permitting him to select his own assistants, cannot be too highly commended. His selection of Messrs. Upton, Hazen, and Waldo for this important service has been justified by the numerous valuable contributions which they have already made under his direction. The transfer of Professor Ferrel from the coast survey to the meteorological bureau is another step in the same direction, which is likely to materially increase the strength of the division. In many other directions, the chief signal officer has shown his appreciation of the 'eternal fitness of things.' He has sought and obtained the cooperation of the National academy, in the appointment of a permanent committee of that body to which he may refer such questions concerning meteorological science as may seem desirable. He has inaugurated the custom of consulting specialists upon various matters pertaining to the service, and has shown a disposition to aid scientific research in all matters related to meteorology, as instanced in Professor Langley's expedition to Mount Whitney, in the offer to the coast-survey of cooperation in the making of pendulum-observations, and in the interest shown in polar research. The publication of professional papers by members of the staff; the work undertaken in the way of a revision and definitive establishment of standards of pressure and temperature; a promise that after a while something will be attempted in the way of a study of atmospheric electricity; and the proposition to offer prizes for essays upon various meteorological problems, competition to be open to the world, — are all straws that show which way the wind is blowing.

At the same time, the general observation work has been much extended by the wise and hearty interest which the chief signal officer has shown in the establishment of state weather services, which have rapidly increased in number through his encouragement and material aid. This is particularly fortunate just now, when the general service has unfortunately been crippled by the failure on the part of congress to make sufficient appropriations. In short, it is only just to Gen. Hazen, to say that he has greatly enlarged the scope of the service, and that he has materially strengthened it by a broader recognition of the relations which ought to exist between it and the science of the country.

It is difficult, however, to review the past without indulging in speculations concerning the future. It must be admitted, that the work of the meteorological bureau falls far short of the standard which many of its friends have set for it. Many, indeed, believe that it will continue so as long as it remains a military rather than a civil service. Each successive report of the chief signal officer has contained long arguments in defence of its military organization; and, unintentionally no doubt, the same reports have furnished strong arguments against such organization. In order to improve the character of the observing corps, considerable efforts have been made, for two or three years past, to induce well-educated and well-trained men to enlist in the service. Under the present organization, it does not seem that the work could have any great attraction for a college-bred man. In the first place, he must enlist as a private in the army for a period of five years. It is true that the service is special, and that his chance for promotion up to a certain point is fair; but before beginning his work as an observer, he is obliged to go through months of military drill, study, and discipline, the relation of which, to the duties which afterward devolve upon him, it is difficult to see. Proficiency in the 'manual of sabres' or the 'manual of the kit' will not greatly facilitate his making a barometric reduction or a dew-point determination. Even after the service is fairly entered, objections to the military system are not less strong. Permanency of position is very desirable in any occupation, and it goes farther than most other things in securing the best attainable results; but it must be a permanency very different from that which obtains in a military service.

The difference is best seen by a comparison of the relations existing between the service and the two divisions of the staff of the chief signal officer, the civil and the military. The young civilians who have recently become *attachés* of the central office have been led to do so, it is almost certain, by their own fondness and predilection for the study of meteorology. They bring to their work a vigor and enthusiasm resulting from a thorough collegiate training, followed by post-graduate work in which observation and research have played the most important part. The permanency of their positions, and their advancement to more responsible places, will, or at least should, depend solely on the value of their services. With the laudable ambition to establish a reputation among scientific men, they have every incentive to hard work, that success may be achieved, and failure, which would be to them disastrous, avoided.

But by far the greater portion of the work at the central office, and that which is doubtless the most immediately effective, is done by commissioned officers of the army. While it is true that many of them have fairly earned distinction through their conscientious labors in the weather bureau, it cannot be claimed that the relation which they sustain to it, and which is no fault of theirs, is that which would be for the best interests of all concerned. Except the very few who have been promoted from observer sergeants, they have been ordered to the service from other occupations and other branches of the army. As a special training to fit them for the work, they have the year at Fort Meyer, during which the study of meteorology is not allowed to interfere materially with other occupations. They enter the central office at the close of this year, having had an experience of eight days in practical meteorology. When, after further study and practice, they become really useful, they are likely to be transferred to some other post and duty for which this training has in no way fitted them; for the policy of the army seems to be in the direction of frequent changes of location of its officers. But by far the worst feature of the case is that there is no particular incentive to induce them to devote themselves earnestly to the work. If, through interest and industry, one succeeds, he is probably retained in the office longer than he otherwise would be: if, through indifference and neglect, another fails, he is likely to be transferred to some other branch of the general service without loss of rank or reputation. It is also true that the meteorological work of the signal service is looked upon with disfavor by many army officers, as not being a legitimate addition to their duties. Under such conditions, and for many other reasons not necessary to mention, it does not seem possible for the weather service to reach that high degree of efficiency which is believed to be possible under a different organization; and it will require weightier arguments than those annually reprinted in the report of the chief signal officer to prove the contrary.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ROUEN MEETING, AUG. 16-23, 1883.

This association has just held its twelfth annual session at Rouen, the ancient capital of Normandy, situated on the Seine, between Paris and Havre. It is, I believe, the youngest association of its kind, but is not, for that reason, the less worthy of study. Perhaps, to an American, its most striking feature is its resemblance, in its organization and proceedings, to its sister across the water. It has its permanent secretary to organize its business and give information to members, its daily programmes, its general meetings, its sectional meetings, and its excursions, all fulfilling the same objects as with us. It has even gone through the same process of evolution, and reached the same stage of development, in becoming a representative of popular and applied, rather than of very 'high,' science. Its members already complain, that, when one is elected a member of the Academy of sciences, he no longer affiliates with the association. I have recognized but two academicians at the meeting, and doubt if there are more. But it must not be inferred from this, that the members and their papers are unimportant: on the contrary, the number of eminent teachers, authors, and investigators, who read papers and take part in the proceedings, is decidedly greater than in the American association. If there are fewer academicians than with us, there are also fewer circle-squarers, essayists, and propounders of school-boy problems. On the list of papers presented, there is not one upon atoms, ether, the nebular hypothesis, or the origin of the present form of the universe.

The range and treatment of subjects are much wider than with us, and one is especially struck with the prominence assumed by social science and engineering. It would seem as if the blind passions, which are so apt to stir the laboring population of France and to lead them toward a policy of general social disintegration, had led the thinking and wealthy classes to give especial attention to the question of the welfare and pacification of the workingman. Not only is political economy one of the most prominent subjects, but discussions of plans for improving the condition of the laboring-class form a leading feature of the proceedings. The plan which seems to have met with most success is that of making the workmen in large establishments sharers in the profits. One speaker described, at length, the working of this plan in a great dyeing-establishment, where it would seem to have proved a great success, although coupled with conditions which would hardly have been accepted by an American artisan. I do not know what interest our railway-companies take in the personal welfare of their employees; but the examination of what is done by the Western railway of France, as exhibited and explained to the association, is suggestive of a philanthropic as well as of a business institution. Bedrooms, baths, eating-rooms, medical attendance, savings bank, and life-insurance are among the privileges provided by the company, of which each and every employee may avail himself according to circumstances.

The prominence of engineering questions was due to a cause which shows that human nature is much the same through the civilized world. Rouen is engaged in river improvements, of which the object is to make it a great seaport; in fact, to make it to Paris what Liverpool is to London. Great pains were therefore taken to secure the attendance of distinguished engineers from abroad as well as from home; and harbor improvements, especially those of Rouen, formed the most prominent subjects of discussion in the section of engineering. How far the French association is ready to go beyond its fellows in this direction, is further shown by the fact that one of the prominent papers in the engineering section was devoted to the exposition of a scheme for a metropolitan railway in Paris, similar in its object to those of London and New York, which could be built at a cost of two hundred million francs. No one hinted that the subject was not germane to the objects of the society.

There is at least one custom of the meeting worthy of imitation by the American association; namely, evening lectures by members, on subjects of general scientific interest. These lectures are not gotten up at hap-hazard on the spot, but are arranged by the secretaries, long enough in advance of the meeting to admit of careful preparation. Those of the Rouen meeting were: The transit of Venus, by Mr. Hatt, chief of one of the French expeditions; and on the Transmission of energy, by Professor Comberousse. The general character of these lectures was the same so familiar to us at home; but it was noteworthy, that French science was almost exclusively considered. Occasional references to the works of other nationalities were rather to show that the speaker knew something about them, than to give full information respecting them.

In two points the French association makes a decidedly more favorable showing than our own. One has already been mentioned, — the absence of the respectable gentleman who writes interminable essays on scientific subjects of which he knows nothing except from current literature. In the mathematical section, the papers read were of decidedly greater importance than those to which the American association is accustomed. The other is the financial condition of the society. In few respects does American science show to greater disadvantage, beside that of Europe, than in its power of raising money to promote its objects. The income of the French association for the current year was reported at 85,000 francs. It has already an invested capital of about 450,000 francs. It expended 39,000 francs in printing its proceedings, 20,000 in administrative expenses, and 14,000 in grants for researches of various kinds.

Let us compare this sum total with the income of the American association.

Income of French association	$16,600
" American "	8,943
Difference in favor of France	$7,657

And we must remember that this is not a case in which the excess is due to greater age; for the French society is only one-fourth the age of the American. The comparison will afford us food for profitable reflection.

EVIDENCE FROM SOUTHERN NEW ENGLAND AGAINST THE ICEBERG THEORY OF THE DRIFT.[1]

In presenting to the association evidence from southern New England with regard to the insufficiency of the iceberg theory of the drift, I shall have to say some things that have often been said before, and by various investigators. But I may claim for what is here brought forward, that it is, in my own mind, the fortified conclusion of long-continued investigation.

The arguments on the subject are derived from three sources, —

I. The scratches and groovings over the rocks.

II. The transported bowlders and other material.

III. The facts as to the relative level of the land and sea.

I. The scratches or grooves over the rocks.

Under this head there is, first, the old argument based on the universal distribution of the scratches over the region of all New England. These effects of abrasion are to be

[1] Read at the Minneapolis meeting of the American association for the advancement of science.

found everywhere beneath the soil, each fresh exposure of the rocks bringing them to light. This was said years ago; and the conviction of its truth has been gaining force with every year of additional observation.

a. In view of this fact, it is urged rightly that only an abrading agent that pressed heavily against the broad rocky surface could have produced the effects; and such is not an occasionally grounding iceberg, or a succession of them. Neither is it the still more locally acting shore-ice.

b. Floating ice would have found little bare rock over the sea-bottom to be abraded. Like the bottom of existing seas, and eminently those of the continental borders, the submerged region would have had for the most part a bottom of detritus, its former detritus, and additional detritus from later depositions. The removals would have been local, and relatively of small area. Consequently, the drifting ice would rarely have reached down to the rocks. Shore-ice carried along by the currents would have had a better chance, and yet a poor one, for the work to be done.

c. The character of the groovings and ploughings is, to a great extent, such as floating ice could not have produced. As has been often said, the close uniformity of direction and parallelism over large areas, which so generally prevails, is not a possible result of iceberg action. The needed pressure and steadiness of movement are wanting. Troughs in hard granite even six inches deep are the work of one and the same moving tool for a long period; and one year would be long for the steady action of an iceberg. If grounded, it would do almost nothing; if floating free, absolutely nothing; and a nice adjustment to depth would be required for any steady abrasion, much nicer than would have long continued anywhere over the uneven bottom.

In the triassic sandstone of East Haven, Conn. (just east of New Haven), at a place where the sandstone is a very firm, thick-bedded, gritty rock, the ploughing ice ploughed out a piece of moulding, somewhat like the *ogee* of the carpenter, which was 8 feet deep, 25 feet wide, and over 150 feet long, and perfectly even in surface as well as direction.

d. The currents that would have borne along the icebergs over submerged New England, in case of a submergence sufficient to cover the highest striated surfaces,—3,000 to 5,500 feet,—would have been those of the present ocean, the Labrador current, and Gulf stream; and, with less submergence, the same in part, modified by the courses of the valleys and the tides. It is to be noted, that the New-Haven region, in Connecticut, is the southern extremity of the Connecticut valley. The mean trend of this valley in Connecticut is about S. 15° W., and, in southern Connecticut, S. 18° W. Now, the numerous scratches over the *eastern* portion of the New-Haven region average in direction S. 16° W.; but along its *western* border, where the rapidly rising slopes give the region rather an abrupt limit 150 to 350 feet high, the scratches have an average course of S. 33° W., the extreme being S. 27° W., and S. 55° W.; and S. 33° W. is the almost uniform trend over the undulating surface of the country for six to nine miles west. It is, as far as I can see, impossible that the valley stream should have had on its west side so wide a divergence from the direction of the Connecticut valley: all the features of the region oppose it. The scratches are well exposed over the metamorphic rocks in many places; and large and perfect examples of *roches moutonnées* here occur.

Again: over the higher lands of western Connecticut (and of New England generally, according to the observations of Prof. Edward Hitchcock, Prof. C. H. Hitchcock, and others), the direction of the scratches is south-eastward. To have produced them, if icebergs were the agent, the submergence should have exceeded 2,500 feet, and this would have given a chance for the full play of the oceanic currents; and yet the above direction does not correspond with that of either of the great currents.

II. Distribution of the drift.

Bowlders of trap, from 50 to 1,000 tons in weight, are numerous in the New-Haven region, especially along its western border. All are Connecticut-valley travellers; for the trap ridges of the valley—400 to 1,300 feet in height—are the only possible source. They were gathered up by the ice from these trap ridges, and were carried 15 to 60 miles down the valley. It is mechanically impossible that the larger bowlders should have been taken up, or gathered in any way, by floating ice; either shore-ice, where the water was but 1,000 feet deep and less, or by that of icebergs, where the depth was greater.

It is well known, that the distance of drift transportation is in general less than 20 miles. Hills of but 100 feet often have their long trails. A moving glacier would easily gather and carry along the material from hills, high or low, wherever loose or detachable masses of rock or gravel existed to be gathered; while floating ice would be very poor at gathering, and hence inefficient in distributing.

III. Relative level of the land and sea.

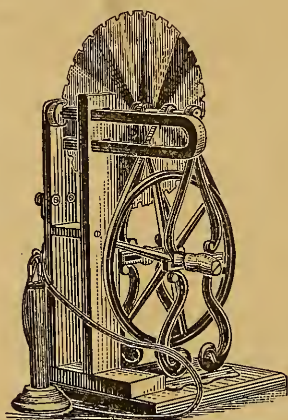
I have examined carefully along southern New England for proofs of the quaternary submergence which the iceberg theory assumes to have existed in the glacial era. I thought at one time that I saw evidence about New Haven of a submergence of 45 to 50 feet. But the terrace that afforded the evidence was situated six miles back from Long Island Sound, adjoining the rivers; and on further examination I found that the deposits had precisely the structure of those along the river-valleys farther north, and that, in fact, they were nothing but fluvial formations. The highest terraces on or near the shores of the sound, in the vicinity of New Haven, have a height above mean tide of 23 to 26 feet; and on Milford bay, nine miles west, a similarly situated terrace has a height of 30 to 33 feet. Along the hills facing the waters, and the southern extremity of the valleys, no traces of any higher level exist. Twenty-five to thirty-five feet is the greatest amount of submergence the facts sustain. Sea-border deposits exist at a higher level on the coast of Maine and on the shores of the St. Lawrence, and show what was the position of the shore-line in those regions. But the level along southern New England is not proved by the facts there gathered, neither is it established by the demands of the iceberg theory.

In conclusion, if icebergs, or floating masses of ice, were not capable of covering with scratches great continuous areas, and would have had a chance for little rock-abrasion on account of the covering of detritus; if they could not have made, in their hitching and swinging way of action, when touching bottom, scratches over great areas, that had the even course and parallelism characterizing those of drift regions, or could not have ploughed out the deep furrows; if they could not have gathered the great bowlders for transportation; and if the sea along the sound did not cover the land, in any part of the era of ice, to a greater depth than 30 or 35 feet, — the iceberg theory of the drift may be reasonably pronounced unsatisfactory for southern New England; and similar facts show that it is equally unsatisfactory for the rest of New England.

James D. Dana.

THE MAGNETOPHONE.[1]

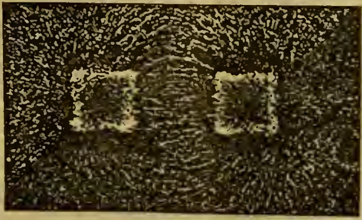
The experiments of Bell,[2] Preece,[3] Mercadier,[4] and others on the radiophone, suggested to me the possibility of interrupting, or at least periodically modifying, the lines of force proceeding from the poles of a magnet, by means of a disc of sheet iron, perforated with a series of equidistant holes, and rotated so that the holes should pass directly in front of the magnetic pole. It is well known that an armature, placed on the poles of a permanent magnet, diminishes the strength of the external field of force by furnishing superior facilities for the formation of polarized chains of particles from pole to pole. This is the case even when the armature does not touch the poles, but is in close proximity to them.



If a piece of sheet iron be placed over the poles of a magnet without touching, and the magnetic curves be developed on paper above the iron, they will be found to exhibit less intense and less sharply defined magnetic action than when the sheet iron is removed. If, however, a small hole be drilled directly over each magnetic pole, the screening action of the sheet iron is modified in much the same way as when a hole is made in a screen opaque to light; for the developed curves show distinctly the outline of the holes. If, therefore, the sheet iron in the form of a circular plate, pierced with a number of holes, be rapidly rotated between the pole of a magnet and a small induction bobbin, the action of the magnet on the core of the bobbin will be periodically modified because of the passing holes; and hence induced currents will flow through a circuit including the bobbin. A disc of sheet iron was pierced with two circles of quarter-

[1] Read at the Minneapolis meeting of the American association for the advancement of science.
[2] Proceedings Amer. assoc. adv. sci., xxix. 115. Smithsonian misc. col., xxv. 143.
[3] Proceedings Royal society, xxxi. 506.
[4] Journ. phys. x. 53.

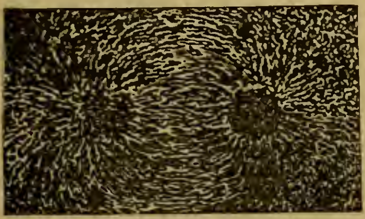
inch holes concentric with the disk, the number of holes in the two circles being thirty-two and sixty-four respectively. On one side of the disk was placed a horse-shoe magnet with its poles very near the rows of holes; on the other side were arranged two corresponding induction bobbins. The circuit was completed through a telephone and either bobbin at pleasure. Upon rotating the disk rapidly, a clear musical sound was produced in the telephone, the pitch rising with the rapidity of rotation. Moreover the bobbin opposite the circle of sixty-four holes gave the octave above the other, and each gave a note of the same pitch as was produced by blowing a stream of air through the corresponding holes. Hence, as a beam of light, focused upon a circle of equi-distant holes in an opaque disk, is rendered periodically intermittent by the rotation of the disk, and produces a musical tone when falling upon the proper receiving-apparatus; so the lines of force proceeding from a magnet may be rendered periodically intermittent in their action on an induction bobbin by a similar metallic disk, set in rapid rotation; and the induced currents, arising from the periodic change of magnetism in the core of the bobbin, produce a musical tone in a telephone, the pitch depending in both cases only upon the number of holes passing in unit time.



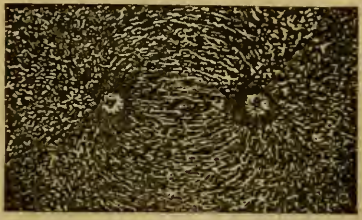
MAGNETIC CURVES OVER HORSE-SHOE MAGNET.

or in opposite directions through the telephone. In the latter case, an almost perfect neutralization of currents took place, so that the sound was scarcely audible.

Non-magnetic metallic disks produce similar musical notes by the periodic modification of the magnetic field by means of the distortion or bending of the lines of force. The solid parts of the conducting disk deflect the lines of force in the direction of the rotation; but upon the passage of a hole, they fall back toward their normal position. A periodic movement of the lines of force will, therefore, take place when the disk rotates. Disks of zinc and copper produce a clear musical sound, somewhat less intense than that given by iron under the same conditions. Any discontinuity in the rotating disk recurring periodically will produce corresponding induction currents in the bobbins. Thus, V-shaped notches round the circumference of the disk are quite as efficient as the holes in effecting the requisite modification of the magnetic field. Moreover, it is not necessary that the holes extend entirely through the disk. Two disks of zinc, of the same diameter and thickness, were placed together on the same rotating spindle, one pierced with a circle of holes, and the other not. The combination proved as efficient in producing the sound as the single perforated disk.



EFFECT OF SCREEN OF SHEET IRON.



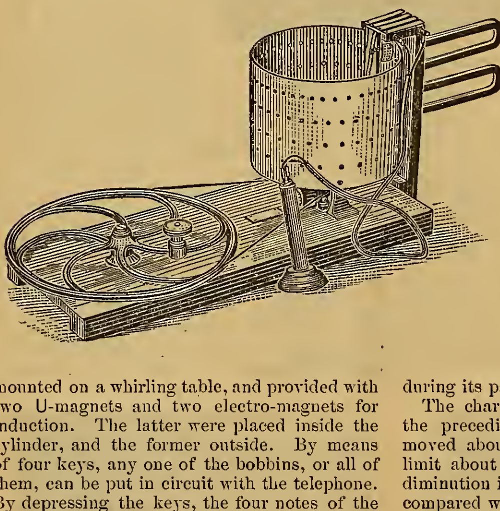
EFFECT OF HOLES THROUGH THE IRON SCREEN.

The experiment was modified by so placing the poles of the magnet that the same circle of holes passed them in succession. By the proper connections, the currents from the two bobbins were made to pass either in the same

A sheet of tinfoil, with a circle of small holes, was pasted on the continuous zinc disk. The perforations, extending only the thickness of the tinfoil into the compound disk, constituted a sufficient discontinuity to produce a clear, though somewhat faint, musical sound. About the same result was given by a disk consisting of the same sheet of tinfoil pasted on cardboard.

Any periodic variation from uniformity in the disk appears to produce corresponding variations in the magnetic field when the disk is rotated. Depressions made with a punch, at regular intervals, in a zinc disk, rendered it a sound-generator when rotated in this apparatus.

Since the pitch of the note obtained depends only on the number of holes passing the pole of the magnet in a second, it is easy to construct a piece of apparatus to illustrate musical intervals. A cylinder of galvanized iron, with four rows of holes in the ratio of 4 : 5 : 6 : 8, was



mounted on a whirling table, and provided with two U-magnets and two electro-magnets for induction. The latter were placed inside the cylinder, and the former outside. By means of four keys, any one of the bobbins, or all of them, can be put in circuit with the telephone. By depressing the keys, the four notes of the common, or major, chord are brought out with great distinctness and clearness. In fact, the intensity of the sounds obtained by the magnetophone is sometimes so great as to be painful to the ear when the telephone is held closely against it.

The above experiment was simplified by employing a disk perforated in four concentric circles with 24, 30, 36, and 48 holes respectively. A telephone with the mouthpiece and diaphragm removed, was presented to the four rows of holes in succession, with the production of the four notes of the major chord as before, clearly defined, but not so loud as with the other apparatus. Further experiments are in progress. H. S. Carhart.

Evanston, Ill.

THE WEATHER IN JULY, 1883.

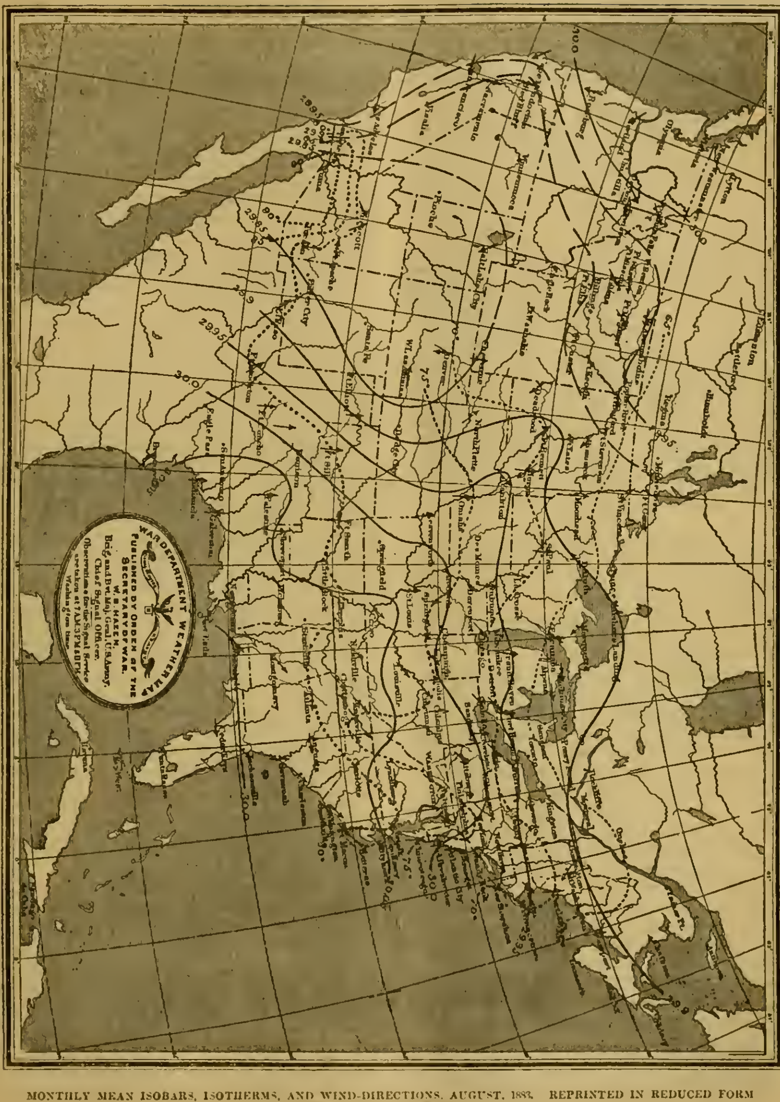
The monthly weather review of the U.S. signal service shows that the most noteworthy characteristics of July were the large deficiencies in rainfall in the southern states and in the north-west, the low mean temperature in nearly the whole country, and the severe local storms, which were frequently accompanied by lightning and hail.

The pressure was nearly normal, the departures in few instances exceeding .05 inch. The progress of eight depressions has been charted. Only one of these passed south of New England, and none visited the southern states. None were traced from the Pacific coast, and four apparently developed in the Rocky-mountain region. One only of these depressions is deserving of the name of a severe storm. This developed in Colorado on the 4th, and reached Nova Scotia on the 7th, accompanied by heavy rains in the lake region, and violent local winds at Hatteras and Sandy Hook. The storm proceeded across the Atlantic, and on the 11th was central off the north-western coast of Ireland, causing heavy squalls and high seas during its passage.

The chart of ocean-ice shows, that, since the preceding month, the eastern limit has moved about 2° westward, and the southern limit about 2° northward. There is a marked diminution in the number of icebergs observed, compared with July, 1882.

The temperature has been below the average, except in the Pacific districts, the northern plateau region, the south Atlantic and east gulf states; but the departures have been small. In New England, the middle Atlantic and west gulf states, the temperature was less than 1° below the normal, while the greatest difference was 3° below in the extreme north-west. A maximum of 112° was recorded at Phœnix, Arizona; and frosts occurred in northern New York, Michigan, Wisconsin, Iowa, New Hampshire, and Pennsylvania.

The special feature in the precipitation record



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, AUGUST, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF CHIEF SIGNAL-OFFICER.

is the large excess in the upper lake region, New England, and the upper Mississippi valley; and the large deficiency in the southern states, which materially affected the crops in that section. The following table contains the rainfall record: —

Average precipitation for July, 1883.

Districts.	Average for July. Signal-service observations.		Comparison of July, 1883, with the average for several years.
	For several years.	For 1883.	
	Inches.	Inches.	Inches.
New England	3.92	5.76	1.84 excess.
Middle Atlantic states .	4.04	3.28	0.76 deficiency.
South Atlantic states . .	5.65	4.92	0.73 deficiency.
Florida peninsula . . .	5.77	4.49	1.28 deficiency.
East gulf	5.04	2.50	2.54 deficiency.
West gulf	4.16	2.44	1.72 deficiency.
Tennessee	4.06	3.07	0.99 deficiency.
Ohio valley	4.55	5.35	0.80 excess.
Lower lakes	3.84	4.51	0.67 excess.
Upper lakes	3.36	5.42	2.06 excess.
Extreme north-west . .	2.83	2.44	0.39 deficiency.
Upper Mississippi valley,	4.02	5.58	1.56 excess.
Missouri valley	4.44	3 37	1.07 deficiency.
Northern slope	1.94	0.82	1.12 deficiency.
Middle slope	2.77	2.57	0.20 deficiency.
Southern slope	2.50	3.19	0.69 excess.
Northern plateau . . .	1.01	0.00	1.01 deficiency.
Southern plateau . . .	2.35	2.50	0.15 excess.
North Pacific coast. . .	0.58	0.00	0.58 deficiency.
Middle Pacific coast . .	0.01	0.00	0.01 deficiency.
South Pacific coast. . .	0.08	0.15	0.07 excess.

In some portions of the southern states, the deficiencies were even greater than those recorded in the above table: at New Orleans the rainfall was 5 inches less, and at Vicksburg 6.82 inches less, than in July, 1882. Eastport, Me., reports a fall of 5.24 inches in 10 hours, on the 14th inst.

The local storms reported are very numerous, and much damage resulted from rain, lightning, and hail. The greatest damage from rain was at London, Ont., on the 10th, due to the overflowing of the river Thames. Much damage to crops, especially in the west, was caused by hail. A vessel in lake Michigan reports a hail-stone weighing two pounds. The rivers were not high, except at the very beginning of the month; and navigation was suspended in the Savannah and Cumberland rivers on account of low water.

Among miscellaneous phenomena may be noted the brilliant aurora on the nights of the 29th and 30th, which was observed from Dakota eastward to New England, and southward to southern Virginia. Slight earthquake shocks were experienced in Nevada, Illinois, California, and Kentucky; though insignificant in comparison with that on the island of Ischia, of which a condensed account is given. Sunspots were numerous; and an instance is noted in Oregon, of their observation with the naked eye, taking advantage of the smoky state of the atmosphere caused by forest-fires.

The accompanying chart represents the distribution of the mean pressure, temperature, and wind direction for the month.

THE EARTHQUAKE OF JULY 28, 1883, IN THE ISLAND OF ISCHIA.[1]

HAVING visited the island of Ischia by order of the inspector-in-chief of the Royal corps of mining engineers, a few days after the earthquake of the 28th July, I present some observations made during my short tour; and begin with a brief account of the topographical and geological conditions of the island, which last are, without doubt, the chief cause of the terrible disaster.

The formation of the island of Ischia is wholly volcanic, with the exception here and there of some argillaceous elevations, of marine formation, but derived from the disintegration of pre-existing volcanic matter. In connection with the islands of Vivara and Procida, it belongs to the volcanic group of the Campi Flegrei, and forms its western limit.

The aspect of the island as seen from the north is pleasant and delightful, although with deep hollows crowned by the towering and indented crest of Epomeo, rising to an elevation of 792 metres.

The town of Casamicciola, now destroyed by the terrible scourge, was built on the side of Epomeo sloping towards the north, upon two small hills, beside which flow two of the principal streams of the island, one near the mountain, fed chiefly by the waters of thermal springs, the other emptying into the sea near Lacco Ameno, a little farther to the west; these run from south to north; and another more important stream, called the Scarrupato, runs from north to south, flowing through a deep and precipitous valley on the southern slope of the island, having on its banks the villages of Fontana, Serrara, Moropane, and Barano. These last two streams are, in my opinion, very important; being, as we shall see, situated directly in one of the principal gorges of the island.

Forio is on the west coast, upon a plain gently rising towards Epomeo, bordered upon the north by Mount Zale. Eastward of Casamicciola are seen the volcanoes of Monte Rotaro and Montagnone (respectively 215 and 236 metres in height.)

According to Fuchs, the most ancient terrane of the island is composed of the tufa of Epomeo, of a clear green color, containing numerous sanidin, and sometimes pumice and lapilli. On this rest, here and there, strata of pumice and trachytic tufa, and depositions of trachytic lava, with beautiful sanidin from the mountains Rotaro, Montagnone, Tabor, Garofali, etc., which may also be seen on the road from Lacco Ameno to Forio, forming the promontory of Zale.

On the tufa of Epomeo rests a great extension of

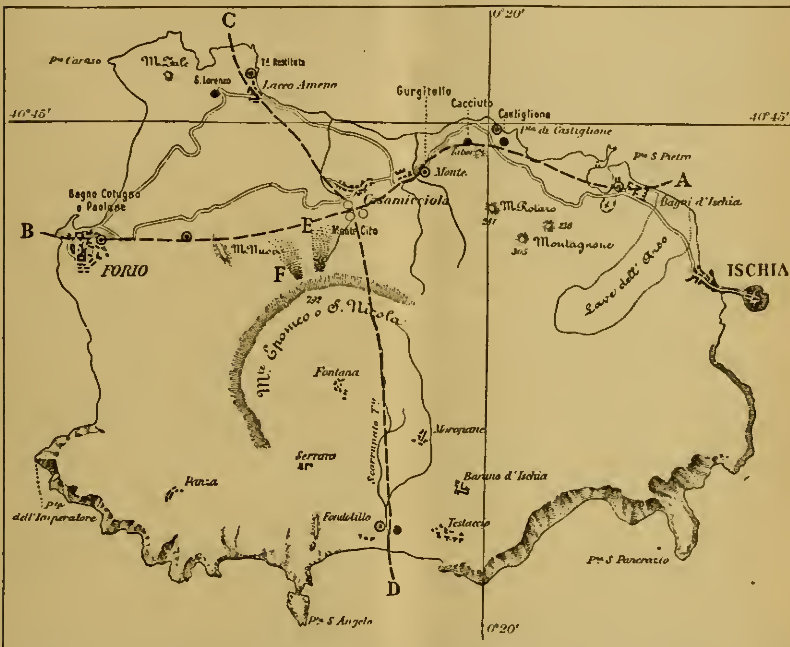
[1] Translated from the Italian of L. Baldacci of the Royal corps of mining engineers (*Boll. R. com. geol.* 1883, nos. 7, 8).

a product of decomposition of this tufa, of submarine origin, which passes occasionally into a plastic argillite well suited for the making of brick. Casamicciola was built upon this disintegrated clayey soil; while Lacco is partly upon trachyte, and partly upon the tufa of Epomeo; and Forio, as also Fontana, Serrara, etc., are built exclusively upon the above-mentioned tufa.

To these formations constituting the island must be added the trachytic lava and scoriae of Arso, the last eruption of which occurred in the year 1301; and, finally, the gravelly or clayey deposits, containing numerous marine fossils of species now living, indicating, that, in an epoch not very remote, a great part of the island was submerged.

For the description and analyses of the rocks forming the soil of Ischia, we must refer to the very important monograph of Fuchs previously cited: what chiefly interests us now is to observe how they are connected with the manifestations of innate activity which are developed in the island. These are of three classes, — hot mineral springs, stufas or jets of aqueous vapor, and fumaroles. These will be easily seen on the accompanying chart. They could not all be given with so small a scale, but I was obliged to limit myself to the most important.

The northern coast contains the chief evidences of volcanic activity. Thus, traversing the coast from east to west, we find the thermal springs of Pontano, Fornello, and Fontana, near Ischia; the stufas and thermal springs of Castiglione, near the point of that name; the stufas of Cacciuto, on the trachytic lava of Tabor; the rich and abundant thermal springs of Gurgitello, near the mountain (il Monte) at Casamicciola, besides others, less important, in that neighborhood; the fumaroles of Monte Cito, to the west of Casamicciola, which on the day of my visit was actively emitting steam and sulphuric acid from different crevices in the tufa of Epomeo; and, finally, trending slightly to the south-west, the thermal springs which are so valuable at the Bagno Cotugno or Paolone of Forio, and which flow from the side of Monte Nuovo



ISLAND OF ISCHIA, EARTHQUAKE OF JULY 28, 1883.
⊙ Hot mineral springs. ● Stufas and jets of steam. ○ Fumaroles. AB, CD, supposed fissures. E, F, Land-slides, happened since July 28.

at the east of that town. In these jets of water, steam, and gas, the temperature always ranges from 40° to 100° C.

From these elements, it appears to me, we may reasonably conclude that there exists a large curving line of cleavage from which arise such manifestations, turning its convexity chiefly to the north, running between the baths of Ischia and Forio, and passing exactly through Casamicciola (A B on the chart).

Examining now the other principal manifestations from north to south, we find in Monte Zale and Marecocco, near Lacco Ameno, the thermal springs of Santa Restituta and the stufas of San Lorenzo, the fumaroles of Monte Cito, already mentioned, in the stream which flows into the sea near Lacco; and in the same direction, on the other slope of Epomeo, we have the valley of the Scarrupato, at the southern end of which we find the hot springs of Fondolillo and the stufas of Testaccio. I am assured that on this line will be found other similar but much less important fumaroles, also on the heights of Monte Epomeo; but for want of a guide or exact indications, I cannot verify the assertion. Therefore, also, there is evident to me the existence of another fracture running from north-north-west to south-south-east, which crosses the first exactly at Monte Cito, almost under the town of Casamicciola (C D). These two grand lines of fracture are designated by broken lines drawn upon the annexed chart.

The reason which inclines me to believe that there are two principal fractures, and not an intersection of the fracture C D with the line of superposition of one crater (that of Epomeo) upon another, submarine and more ancient, according to the opinion of the celebrated Prof. de Rossi, is the identity of the manifestations along the two lines, A B and C D; the thermal springs, the stupas, and the fumaroles being identical in the two cases, I believe that they may be more simply attributed to an identical cause, without having recourse to hypotheses hitherto not entirely demonstrable by facts.

As to the phenomena which heralded the terrible disaster, the information collected on the spot is somewhat contradictory. It is certain only, that, for some days previous, slight shocks were felt with faint rumblings; that the springs of Gurgitello, etc., had shown irregularities of quantity and temperature; and that the fumaroles of Monte Cito, hitherto almost inactive, had evinced symptoms of excitement, emitting a peculiar hissing and quick jets of steam and sulphurous acid. It is said that the wells of Casamicciola and Forio were almost dried up, but that assertion does not agree with the facts. There are no spring wells in Casamiccola and Forio, only cisterns; and a scarcity of water observed in some, not all, of these, might perhaps be attributed rather to the drought prevailing for some time in Ischia, than to cracks in the walls of the cisterns. At Forio, I learned from trustworthy persons, that, in the cisterns between San Pietro and the upper part of the town, a remarkable increase of temperature was observed in the water. That seems highly probable, such cisterns being exactly in the direction and neighborhood of the great fracture above described.

The shock which brought desolation upon these lovely regions occurred on the evening of 28th July, at 9.25 P.M. I need not dilate upon its deadly effects, which are already too familiar from numerous accounts. The shock was accompanied by a horrible bellowing, and lasted, apparently, twenty seconds. Casamicciola, Lacco Ameno, and Forio were almost levelled to the ground, with a frightful sacrifice of life; Serrara, Fontana, and other lesser villages suffered terrible injury. The seismic disturbance was felt at Ischia, — where, however, it did but little damage, — and extended to great distances, having been indicated by the seismographs at the geodynamic observatory of Rome.

At Casamicciola and Lacco Ameno, the shock was vertical at first, and then undulatory. Information obtained at the place, and the few observations which I was able to make, indicate that the direction of the wave at Casamicciola was from west to east, then from north to south; at Lacco Ameno, from south-east to north-west; at Forio, the shock was first vertical, then undulatory, and the direction from north-east to south-west. In examining the localities destroyed, I could observe but little in respect to the greater or less resistance offered to the shock by buildings according to their orientation: this idea was advanced by Prof. de Rossi in his account of the earthquake at Casamicciola, in March, 1881, and is certainly based on sound reasoning and also on proved facts. But, in the first place, this shock was so violent and complete that but few walls had been left standing; and secondly, at the time of my visit to Casamicciola, eight days after the catastrophe, the state of the ruins was no longer such as was caused by the earthquake alone: many walls had been torn or thrown down, in order to render less difficult and dangerous the work of rescuing the living, exhuming the dead bodies, and searching among the ruins.

Among other things, I could perceive that some of the walls still standing presented crevices at an angle inclined 30° or 40° from the vertical, with the apex upward, indicating a prevailing upward and downward movement.

On the upper portion of the front wall of the church of the Anime del Purgatorio, in Forio, I observed a clean horizontal crack, showing here, also, the decidedly vertical character of the shock. This character seems confirmed by the condition of a large gate at a short distance to the east of Forio: only the two blocks of stone forming the lower part of the jambs remain in place; the two blocks upon them are thrown towards each other, projecting about six centimetres from those beneath, while the upper parts and the arch have fallen down.

Between Forio and Casamicciola, it seems as if the greatest seismic activity had been manifested along the road joining the two towns, passing by S. M. delle Grazie, and under Fango. The road is, in fact, completely destroyed, and the little cottages that bordered it are ruined. Besides this, the shock has produced two great land-slides, which, descending from the precipitous flanks of Epomeo, have covered a wide extent of chestnut-groves and vineyards; and on the southern slope are great fissures in the earth.

In summing up my observations of all the localities most devastated by the calamity, I am convinced that the buildings standing upon the trachyte at Lacco Ameno and Monte Zale suffered incalculably less than those built upon the tufa of Epomeo and the argillite resulting from its disintegration. Casamicciola was almost entirely built upon this argillite; and it can be said without exaggeration, that not one stone rests upon another. Forio was built upon tufa; and of this town, also, very little remains standing. At Lacco, the houses and walls erected on the trachyte offered, as was stated above, great resistance to the shock, while those built upon the tufa were destroyed.

This agrees completely with the theory of Mallet. Mallet says, that when a seismic or a terrestrial wave passes rapidly from a soil possessing limited elasticity, — as would be the case with our tufas and clays, — to another soil of great elasticity, like the trachytic lavas, it changes not only its velocity, but in some degree also its direction; one part being reflected, the other refracted. The seismic wave, being thus checked, produces a shock in the opposite direction, causing great injury to buildings by the recoil. At the same time the shocks are diminished in force when they reach the more elastic soil, such as granite or trachyte.

This would explain very satisfactorily why Ischia, separated from the cleft AB by the great masses of trachytic lava of Rotaro, Montagnone, and Arso, which would absorb much of the energy of the seismic wave, felt it in so slight a degree.

With respect to the causes of these seismic disturbances, which still continued after the great earthquake of the 28th July, other shocks, accompanied by subterranean rumbling, being felt even when I was on the island and afterwards, it seems to me that they must be attributed to an awakening of the residual volcanic activity of Epomeo. The opinion has been advanced by the illustrious Professor Palmieri, that the violence of the shocks might be especially attributed to the fact of the existence of great subterranean caverns directly beneath Casamicciola, and to the giving-way of the supports which upheld these vaults, caused by seismic action, and facilitated by the weakening of these supports by the underground flow of thermal waters. This opinion does not appear to me to be fully demonstrable. There exist, it is true, in the neighborhood of Casamicciola, caverns of plastic argillite, formed by the lapse of ages; but certainly it is not of these that the illustrious professor of Naples intends to speak: the cause would assuredly be insufficient to produce effects so imposing, and such far-reaching seismic disturbances. I could not enter these caves, for want of persons disposed to serve as guides at such a time; but it is certain that they could be only more or less tortuous galleries of small diameter and but a few metres in height, as is generally the case in such formations. I have been assured also, by persons worthy of trust, and experienced in these caverns, that this is the case. Besides, neither at Casamicciola nor in the vicinity could I see any lowering whatever of the level of the soil: the roads which lead from Guardiola or the shore to Casamicciola, from Casamicciola to Lacco, from Lacco to Forio, have preserved their level perfectly, and show only the longitudinal or transverse fissures inevitable after such a telluric commotion. The only road completely destroyed (but not depressed) is that which leads from Forio to Casamicciola, along the side of Monte Epomeo, which, as we have seen, is directly along the cleft A B.

In any event, when this period of desolation and ruin has passed, when perhaps the time shall have come to decide upon the fittest place to rebuild the shattered dwellings, it would be useful to make a most accurate inspection of all the ancient and modern caverns of the island, and to determine what influence they may have upon the stability of the soil and the superincumbent buildings.

In conclusion, then, it appears to me, 1°. that no other cause need be sought for the shocks which have desolated the island than the volcanic activity which still remains, and awakes at intervals; 2°. that the residual volcanic activity of the island is manifested along two principal fissures, one, A B, a curve with its convexity to the north, from the baths of Ischia to Forio, the other, C D, directed approximately north-north-west and south-south-east, between Lacco Ameno and the stufas of Testaccio; 3°. that the place where Casamicciola stood is upon the intersection of these two lines, and, therefore, at the very focus of seismic activity, and that it has been, and always will be, the locality most liable to be devastated by earthquakes; 4°. finally, that buildings erected upon trachytic lava offer a resistance to the shocks, far superior to that of buildings erected upon tufa or clay, and that this circumstance should be borne in mind when it is proposed to restore the ruined villages.

Rome, Aug. 9, 1883.

JULY REPORTS OF STATE WEATHER SERVICES.

A number of states have organized weather services which are of material benefit to the people. A brief summary of the July reports that have been received is here given.

Georgia. — The July crop report contains meteorological data from fifteen stations. The special feature is the drought, of which it is said, "In northern and middle Georgia, the drought has been almost continuous since April 23, — the date of the last general rain in the state, — broken only by light and ineffective showers at considerable intervals. A few points reported sufficient rain, but the northern half of the state, with these exceptions, has suffered a most prolonged drought, which is yet unrelieved."

Illinois. — Minimum temperatures of 47° were reported, and maximum of 99°. The prevailing wind direction was south-west to south; the highest wind velocity was eight miles per hour.

Indiana. — The special feature of this report is the minimum temperature of 50°; the highest temperature noted was 96°, and the rainfall varied from 2.83 to 7.72 inches.

Iowa. — In this state the weather "was very favorable to the crops, being fair, nearly normal in temperature, with an excess of rainfall, and southerly winds prevailing." The greatest rainfall was that of nearly ten inches in north-eastern Iowa, from the 20th to the 23d inst. A number of severe squalls and local storms were reported, which did much damage. Insolation has been high, because cloudy days were rare; the sun thermometer exceeded 140° on twenty-one days.

Kansas. — The report includes one station only, — Topeka; and the month is reckoned from June 20 to July 20. On fifteen days the temperature exceeded 90°, the maximum being 98°. "On June 23, just after a heavy rainstorm, the air having had a temperature of 65° to 70° all the forenoon, the temperature suddenly rose more than 20°, in consequence of a hot current of air from the south. This lasted but half an hour, when the temperature fell as suddenly as it had risen."

Missouri. — The temperature has been considerably below the normal; there being but five instances since 1837, when lower average temperatures in July have been recorded. A minimum of 52° was observed. On the 13th a destructive wind-storm passed through the north-western and northern portions of the state. A railway train, near Browning, was blown from the track, and many towns suffered much damage. This storm was not a tornado, but 'a steady straight blow for upwards of half an hour.'

New Jersey. — The maximum temperatures range from 91° to 98°, the minimum from 52° to 61°, the rainfall from 2.21 to 4.38 inches.

Ohio. — The mean height of the barometer, 30.025 inches, was higher than that of either of the three months preceding. A minimum temperature of 43° was reported. The rainfall ranged from 1.55 at Lebanon to 7.23 at Quaker City, and was above the July normal. "The railway weather signals were continued during July, and by examination of the reports it is found that eighty-six per cent of the predictions were verified." The predictions are those of the U. S. signal office.

Tennessee. — The temperature ranged from 56° to 98°. A range of 0° was reported from Smithville on the 7th. The rainfall ranged from 1.20 to 7.99 inches. Rain fell on the average on nine and two-thirds days, but the rainfall was rather unevenly distributed. "In some localities the extensive rains have greatly injured the crops of wheat, oats, and hay that had been cut, causing the former to sprout, and rendering much of it unmarketable, while in other localities a continuous drought has materially lessened the chances for the growing crops, which were full of sap, and it will require very favorable conditions during the coming month to even partially restore them." W. U.

THE MEETING OF SWISS NATURALISTS.

The sixty-sixth annual reunion of the *Société helvétique des sciences naturelles* took place this year at Zurich, Aug. 6–9. As at all these Swiss meetings, discussions were happily mingled with daily banquets, at which toasts were offered to fatherland, to guests, and to the older honored names in Swiss science, — Studer, Heer, and Mousson, founders of the society. Sometimes German, and sometimes French, was spoken, and sometimes both by one speaker in the same speech. This year this venerable society gathered men of many countries, and Zurich received them cordially. Daubrée and Hébert of Paris were there; Lory of Grenoble, Credner of Dresden, Fritsch of Halle, Fontannes of Lyons, Hughes and Madame Hughes of Cambridge, Blanford of London, Dewalque of Liège, Kölliker and Fick of Wurzburg, Kundt of Strasburg, Clausius of Bonn, Szabo, Schuler, and Wartha of Budapest, Wislicenus of Wurzburg, Krauss of Stuttgart, von Hauer, Suess, Neumayr, Mojsisovics, and Goldschmidt of Vienna, Vilanova of Madrid, Beyrich and Richthofen of Berlin, Capellini of Bologna, Giordano of Rome, Wiedmann and His of Leipsic, and Seguin of New York.

From communications to the *Journal de Genève*, under initials which we presume to refer to the well-known physicist, Raoul Pictet, we glean the following account of the scientific sessions of the meeting, which began on the morning of Aug. 7.

Mr. Cramer, professor of botany at the university of Zurich, and president of the assembly, opened the meeting with a very noteworthy address before an interested audience of more than three hundred persons. He reviewed the chief progress of the natural sciences, and laid particular stress on the study of those minute organisms which constitute life within life, and whose appearance and development accompany epidemic diseases among men.

Reports on the various commissions (on finance, geology, geodesy, earthquakes, etc.) were followed by two communications from Profs. V. Meyer of Zurich and H. Fol of Geneva.

Mr. Meyer traced the progress of chemistry under the influence of the ideas of Mendelejeff and L. Mayer. He explained how these investigators had been able to classify all simple solids under five distinctly separated families. All these bodies are similar as to their general properties, the gradual increase of their atomic weights, the similarity of their chemical reactions, their atomic volume, etc. These likenesses are so striking, that the memorable discovery of gallium by M. Lecoq de Boisbaudran of Paris was foreseen three years before that simple body was separated. The density and atomic weight of this metal had been determined by calculation before its actual presence was demonstrated beyond doubt by the well-known experiments of the French chemist.

Professor Meyer concluded by showing the indebtedness of science to men who think, to men who found theories on experiments, and then verify the truth of their hypotheses by renewed investigations. It is beyond question, that the labors of Mendelejeff and Meyer are the point of departure of a rational classification of matter, and that they have been a fertile source of useful chemical discoveries.

Professor Hermann Fol of the university of Geneva described his studies on animal individuality. In the lower animals, individuality is a different thing from what it is in the higher, such as the mammifers. But this law of individuality among the vertebrates is not without exception; and we all know the wonder which is excited by the sight of creatures with some member double, such as are often exhibited at shows, or may be seen in museums.

For a long time we have tried to explain the origin of these anomalies. Two theories have been proposed, — that of the creation of two distinct beings, and that of the partial division of one primitive simple. Neither of these theories quite accounts for the phenomena observed. The new and essential fact which Mr. Fol presented comes under the general law, that in these abnormal cases two heads always appear in the egg at the commencement of its development. The body forms immediately behind; and these two trunks, coming together, are so perfectly united that the two primitive heads are very near each other at the outset. In the first place, then, only the higher part of the body is duplicated in these montrosities; yet these two parts may become completely separated, resulting in twins, which so closely resemble each other that even the parents find difficulty in distinguishing them.

Mr. Fol has investigated the causes of the appearance of two embryos in one egg, by a very neat method. He asphyxiated the eggs of Echinus by immersion in Seltzer water (containing pure carbonic acid); and he ascertained that in this unhealthy condition, maintained for a moment, two germs at the instant of passage into life could simultaneously have birth.

Our individuality is one of our most cherished ideas. The great philosophers Descartes, Kant, etc., did not investigate even the possibility of a multiple individuality: it is interesting to observe the flexibility of that idea under the disturbing influence of special conditions of the origin of life.

Mr. Fol exhibited plates representing different kinds of montrosities: two heads and one body, a little body projecting from the eye of a child otherwise relatively well formed, etc.

Professor Herzen of Lausanne, in closing the session, invited all the doctors present to observe an exceedingly interesting case, — that of a man who was on the point of dying from hunger, the results of strangling, when M. de Cérenville of Lausanne began his experiments. This skilful surgeon arranged a stomachic fistula by which the man ate. He was regularly supplied with food, recovered his strength, and rapidly improved. Mr. Herzen took care of this man at his laboratory, and studied the phenomena of digestion according to the process which recalls the well-known Canadian case of M. de Beaumont.

The next morning the association met in sections in different halls. Unfortunately the gift of omnipresence was not given to man, and the members of one section could with difficulty glean here and there any knowledge of what was taking place in the neighboring halls. Besides it would take a volume to contain such a quantity of material, of which a *résumé* will appear in the September number of the *Archives des sciences physiques et naturelles.*

The following account treats only of the subjects taken up in the single section of physics.

Professor Clausius of Berne was elected, by acclamation, president; and Mr. Weber of Neuchâtel, secretary. Mr. F. A. Forel submitted a very interesting paper on the variations of temperature which the Swiss lakes undergo, from summer to winter, and from morning to night. It seems that in an average year the variations of temperature in the year are scarcely noticeable at a greater depth than 60 to 80 metres; above that, the surface of the water is for these lakes between 4° and 5.4°, the highest temperature corresponding to that of Lake Geneva. The variations are felt at a mean depth of ten metres.

After a lively discussion of the manner in which the currents of water influenced by these variations of temperature are set in motion, Prof. Charles Soret of the university of Geneva submitted the results obtained with his new apparatus, the refractometer. This first set of experiments dealt especially with the crystals of the alum-series whose radical is an alkaline metal. This very clear communication was especially remarkable for the skill with which the young professor set forth his subject with a great number of new facts in a comparatively short time. He was followed by his father, Prof. L. Soret, who presented a paper for Mr. L. E. Sarasin, and demonstrated by figures and curves the values of the index of refraction of fluor spar, a crystal, which, since the important works of Cornu and L. Soret, has taken so important a place in the construction of the achromatic lenses of spectroscopes. This paper was marked by extreme precision.

Mr. L. Soret presented a communication to the section of chemistry, belonging in great part to the section of physics. He set forth how the absorption bands seen in the spectra of solutions of albuminoid substances could be used in ascertaining the chemical nature of these solutions. These absorption bands are found especially in the ultra-violet; and, thanks to the fluorescent eye-piece invented by the speaker, their presence renders an analysis very rapid and simple.

Professor Clausius of Bonn gave us a lesson in mechanical electricity: he considered the problem of the production of electric currents by mechanical means. All the knowledge of this scholar, this enthusiastic and ingenious investigator, was necessary to obtain the final solution of so complicated a problem. The paper was heartily applauded.

Mr. Casimir de Candolle repeated, before the members who were present, some experiments to show how sand-ripples at the bottom of our lakes are formed. These facts were applied, in accordance with the ideas of Professor Strasburger of Bonn, to explain certain appearances of envelopes and vegetable cells in fossils.

Mr. Raoul Pictet presented an experimental demonstration of the second law of thermo-dynamics, deduced from the simultaneous working of steam-engines and frigorific apparatus.

Professor Weber of Zurich presented two interesting papers: one, on a dynamic method for the exact measurement of the coefficient of conductibility of heat in liquids; the other paper, on the apparatus for measuring electric units.

Mr. H. Dufour of Lausanne distributed among the audience a set of photographs showing the electric condition of the air, which were obtained by means of a registering electrometer in the new physical laboratory at Lausanne. These curves are so connected with the condition of the heavens, that it is no exaggeration to expect to predict the weather several days in advance, through a careful examination of the variations of electric tension of the air. For fine weather, the electric tension is strong; it sensibly decreases during and before storms; the rapid falling of the curve of the electric potential of the air is always an indication of rain or storm.

The late hour made it impossible to listen to five additional communications which had been announced. The boat for an excursion on the lake awaited its guests; science paled before the beauties of nature. Though continuing to converse on the subjects treated, we all together betook ourselves to the pier. The excursion was delightful. On our return, the streets were illuminated; Bengal and electric lights mingled their dazzling rays. The citizens of Zurich gave us a magnificent reception; and the *fête*, enlivened by an excellent orchestra, was continued to a late hour.

The next morning, Thursday, we listened to three scientific papers which closed the intellectual part of the reunion.

The honors of that morning belong to Professor Suess of Vienna. With consummate skill he set before us the chief points of the modern theory of the upheaval of mountains: he held his audience with great ease, and left a refreshing memory with all who heard him.

This paper, with that of Mr. Heer which followed, will be issued in full in the memoirs of the society.

The afternoon was given up to leave-takings. Seated around the long tables of the hotel L'Uetliberg, thanks and farewell were said again and again. Toasts of gratitude, toasts to the absent, to the present, to Clausius, to Mousson, Oswald Heer, and Studer, founders of the society, were applauded by all, glass in hand.

Appended to this account, appears a list of the principal papers offered in the other sections.

In the botanical section, Professor Heer spoke of the cretaceous and tertiary flora of Greenland; Mr. Schnetzler, of a Chinese primrose in which the sexual organs corresponded to an earlier stage in the evolution of Primulaceae, and on certain relations between an aërial alga and lichen; Mr. Favrat discussed the hybrids of two species of primrose and of other plants, and called attention to the changes in a Cardamines growing in turfy soil. Mr. Andreae spoke of pasturage on the Jura; and Mr. Casimir de Candolle drew attention to a curious Cytisus bearing both red and yellow flowers.

In the chemical section, Professor Krafft read a paper on the preparation of saturated alcohols; Professor Soret, on the absorption of the ultra-viole rays by the albuminoid substances; Professor Schulze, on the composition of cheese; and on phenylamido-propionic acid; Prof. Victor Meyer gave a new method for determining the vapor density of Cl. Br. I. for high temperatures, and reported on a new series of bodies, which he termed *thyophènes*, contained in benzol. Professor Wislicenus of Wurzburg offered a contribution to the theory of Van t'Hoff; and made a communication on the action of chloride of phtalyle and of phtalic anhydride on the ethers of malic acid; Professor Schaer recalled the forgotten works of De Saive (in 1756) on zinc combustion; Dr. Goldschmidt showed the action of hydroxylamine on ketones; Dr. Ceresole spoke of acetacetic acid; Professor Lunge, of the manufacture of sulphuric acid; Dr. Schumacher gave analyses of foods; and Dr. Urech exhibited a laboratory-lamp.

In the geological sections, papers were offered by Messrs. Favre, Neumayr, Schardt, Goll, Mühlberg, Fellenberg, Jaccard, Koch, Chevannes, Mösch, Fratech, and Suess.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

Geology of Philadelphia.

In Dr. Frazer's notice of my lecture upon the geology of Philadelphia, there is so little of adverse criticism, that it may seem ungracious to reply to the few points regarded as blemishes. Merely in defence of the use made of certain terms called in question, a few words here may not be out of place.

In describing the Philadelphia gneiss as both Huronian and Mont Alban, there is no confusion, if, as is held by many geologists, the former term is generic, the latter specific.

The term 'creep,' as applied to the pulling-over of softened or broken strata downhill, by the action of gravity, frost, etc., is one frequently used in describing such phenomena in regions south of glacial action. It is used repeatedly in this sense, in a report issued by the Geological survey of Pennsylvania, in 1880.

The term 'hydro-mica slates,' objected to, is not only used by Rogers, Lesley, Dana, Hall, and others, but occurs repeatedly in Dr. Frazer's recent geological reports on Lancaster and Chester counties, being used by himself.

The positive statement regarding the absence of glaciation in Pennsylvania south of the terminal moraine (the immediate 'fringe' in the western part of the state excepted) was made because of certain statements to the contrary quite recently made by a distinguished authority. It was made only after a thorough investigation of every locality supposed to be glaciated.

In conclusion, I may be permitted to say that while, owing to the necessarily limited length of a public lecture, the rocks of Philadelphia could not be so fully treated of as the superficial formations, this latter — and in this region more debatable — subject will form the topic of future lectures, which may perhaps be worthy of further comment by my friendly critic.

HENRY CARVILL LEWIS.

Philadelphia, Sept. 7, 1883.

The pre-Cambrian rocks of Wales.

Those who are interested in the questions raised by Dr. Henry Hicks in his criticism of Professor Geikie in SCIENCE for Aug. 10, may find it to their advantage to consult my paper entitled 'History of some pre-Cambrian rocks in Europe and America,' which appeared in the *American journal of science* for April, 1880 (vol. xix. p. 268–283). I had the good fortune, in 1878, to spend several days with Dr. Hicks, in going over the typical localities previously studied by him, not only at and near St. Davids in South Wales, but also those of Carnarvon, Dinorwic, and Anglesea, Messrs. Tosell and Tawney being our companions, in North Wales. As a result of these studies, I am satisfied that the views of Messrs. Hicks and Hughes are correct, and their criticisms of Professor Geikie well founded.

The Dimetian, alike in North and South Wales and in Anglesea, has both the lithological characters and the stratigraphical relations of the Laurentian of North America. The Arvonian corresponds in like manner to the great series of *hälleflintas* or petrosilex rocks, jaspery and porphyritic, whose distribution on the coast of Massachusetts and of New Brunswick, in the Blue Ridge of Pennsylvania, in Missouri, and on Lake Superior, I have studied and elsewhere discussed (*Second geol. surv. Penn.*, rep. E, p. 189–195). Similar rocks have also been described by Irving in the Baraboo river in central Wisconsin, a locality which I have lately had an opportunity of examining. The conglomerates of Arvonian pebbles, which form the basal beds of the Cambrian near Snowdon, are indistinguishable from those found at Marblehead and elsewhere on our eastern coast, lying on or near the Arvonian.

The Pebidian of Hicks is our typical Huronian, as seen in eastern Canada and around the lakes Huron and Superior. Professor Bonney, who has lately received a collection of these, is struck with their complete resemblance to the Welsh Pebidian which I had seen and called Huronian thirteen years since. The succeeding gneisses and mica-schists (upper Pebidian or Grampian of Hicks, and Caledonian of Callaway), which are our Montalban series, are not met with in Wales, but appear not only in Scotland, but, as I have pointed out, across the channel, in the Dublin and Wicklow hills in Ireland.

The similar succession in the Alps, I have described in a late paper, of which an abstract appeared in SCIENCE for Sept. 7 (p. 322). The student who compares the succession of stratified crystalline rocks alike in North America, in the British Islands, and in southern Europe, can scarcely fail to recognize, in their constant stratigraphical and lithological relations, something like a 'universal law.'

T. STERRY HUNT.

Montreal, Sept. 11, 1883.

SERGEANT FINLEY'S TORNADO STUDIES.

Report on the character of six hundred tornadoes. Professional papers of the signal service, No. vii. By J. P. FINLEY, Washington, *Signal service*, 1882. 19 p., 3 maps, 4°.

Tornadoes: Their special characteristics and dangers. By J. P. FINLEY. Kansas City, 1882. 30 p.

So striking a phenomenon as a tornado, and one so destructive in its effects, would naturally receive much attention; yet, curiously enough, the competent treatment which these storms have received is remarkably inadequate. Those omniscient gentlemen, the reporters of the newspapers, have written much about tornadoes, and many columns of our summer dailies are filled with accounts of them; but, aside from the books of Peltier and Reye, the scientific literature is fragmentary. Half a century ago, at the time of the battle between Reid, Redfield, Piddington, Espy, Hare, and others, over the rotatory theory of storms, the tornado-literature took a considerable development; but it soon fell to small dimensions, and here it has remained until quite recently. The present activity in this field is largely due to the signal service, and Sergeant Finley's contributions form an important part of the current literature.

Mr. Finley's specialty is the collection of facts concerning tornadoes. He has accounts of individual tornadoes in many of the annual reports of the chief signal officer. They represent the facts collected by him on the field of destruction itself. They are evidently gotten together with great care; measurements are made when practicable, and explanatory maps and sketches are numerous. His evident object is to put before the reader the accurate representation of what he saw, encumbered as little as possible by explanatory theories. The result is that his reports are interesting reading, and afford a mine of wealth for the future Kepler of tornadoes.

Not quite so important, perhaps, from a scientific point of view, but of far more general interest, is his report. Its principal feature is the tabulation of the tornadoes discussed, with headings for time, dimensions, velocity, clouds, and other meteorological features. These are summed up, and from the results are drawn various interesting conclusions concerning maxima, minima, and averages.

Mr. Finley's search for accounts of tornadoes has been extensive; but as he has unfortunately given no references, we cannot tell how extensive it may have been. Evidently he has not gone through the Proceedings of the American association for the advancement of science, or he would have found the tornado of Aug. 9, 1851, in Connecticut, recorded, and that of May 3, 1868, at Shanghai, Ill. Nor has he searched through the state agricultural reports, where he would have found that of June 3, 1860, in Illinois, and doubtless others. Again, Niles's American register gives one at Keene, N.H., on July 25, 1807, and at Knoxville, Tenn., on May 25, 1808. The Philosophical transactions would have yielded him one in New England, July 10, 1760; and several others could have been picked up in Blodgett, Piddington, and in the *American journal of science*. Even that of May 22, 1873, in Illinois and Iowa, reported in the publications of his service for 1873, seems to have escaped his attention.

As average results like those deduced by Mr. Finley depend for their value on the number of individual cases taken into consideration, would it not have been wise for him to have collated those occurring in other countries, so far as they were accessible without difficulty? Peltier would have yielded him quite a crop, some of which, by the way, come curiously near home. Other text-books would have given other European ones; and Chinese and African ones have been described, the latter frequently. Tornadoes are by no means exclusively American; and by a comparison with those in the other countries their essential features could be more easily sifted out, and the incidental ones given their proper prominence.

In the pamphlet, 'Tornadoes, their special characteristics and dangers,' the author classifies the rotatory storms. It was in the pursuit of a classification of storms, that he first had his attention called to the insufficiency of our knowledge of this species. Tornadoes are here described in some detail, and numerous directions given for the protection of life and property on their occurrence. It is the best description of the storm known to the writer.

Mr. Finley considers the tornado a much better-defined species than is likely to be acknowledged by meteorologists generally. Right names are extremely useful, but we must not permit them to conceal any underlying unity. By his anxiety to get a clear species, the author shuts out the light which he might get from the study of storms of so similar character that one is compelled to believe that their differences are due only to difference in surroundings. Thus water-spouts are only tornadoes on the water, with circumstances remarkably favorable for observation. They occur not infrequently on the Great Lakes, and the change from tornado to water-spout has been observed more than once. Judging from the only description known to me of the riband storms of British North America (*Cosmos*, 2d series, iii. 274, 275), they are also somewhat modified tornadoes. And while the name cloudburst refers rather to a single feature of subordinate meteorological importance, the phenomenon is probably often of tornado character. Indeed, leaving out of account eddies, which it is not, the tornado differs only quantitatively from the other members of that list of storms which begins with the formation of a cumulus cloud, passes on to thunderstorms and hailstorms, and culminates in the 'low-centre,' the hurricane, and the typhoon. They all find their origin in the transformations of water; and to overlook the relations they have to each other, is to refuse assistance in a problem well-nigh insoluble with that assistance.

It is expressly stated (see p. 4 of the last-mentioned pamphlet), that the gyratory motion is always from right to left. The writer would point out the exceeding difficulties which surround the determination of this point. Some of the early observers saw only indications of a radial inpour, and in the descriptions of tornadoes one frequently finds dextral whirls mentioned. In so small a storm, the earth's rotation would surely have no appreciable disturbing effect; and that, in a difference of latitude of only a few rods, it should originate velocities of a hundred or more miles an hour, is so unlikely that it need hardly be considered. Furthermore on p. 7 the author admits variations in the gyration of the tornado's other self, — the water-spout. So, while unwilling to differ from so experienced an observer on such a point, both the records and general considerations lead the writer to think that the direction of gyration may be indifferently dextral or sinistral.

There is one possible feature of tornadoes which has not yet been definitely proven, but of which we ought now to be able to ascertain the truth or falseness by an investigation like that just discussed; viz., Are tornadoes disposed to return on the same path? The writer spent his childhood in northern Illinois, where heavy hail and other tornado-like storms are not rare. He remembers several instances of their following the exact path of their predecessors. Professor Whitfield (*Amer. journ. sc.*, 3d series, ii. 99) says in regard to southern tornadoes, "It is not an established fact, but it is commonly believed, and with some reason, that the tornado does, in the course of years, return along its beaten path, and that it is unsafe to build where one has ever passed. The house in Pickens county stood on a hill from which a log-cabin had been blown away some thirty years before. I witnessed the last of three, which have passed along the same track. Near Hernando, Miss., three have followed an unvarying line." He suggests that some places are more favorable than others for the production of these storms, which would make them of a more local character than Mr. Finley would be willing to admit.

While Mr. Finley's work, like that of all others, is capable of improvement, the writer believes he has done great service to this branch of science, and deserves the sincere gratitude of both the student of science and the resident in tornado districts. In enabling him to pursue his investigations, the signal service deserves the commendation of the scientific and general public.

ZIEGLER'S PATHOLOGICAL ANATOMY.

A text-book of pathological anatomy and pathogenesis. By Ernst Ziegler; translated by Donald McAlister. London, *Macmillan*, 1883. 360 p. 8°.

This book is a translation, from the German, of a portion of Professor Ziegler's work on pathological anatomy, which appeared two years ago. The work is not as yet completed in German, nor does the translation contain all that has yet been published, covering only the ground of general pathological anatomy.

Professor Ziegler is a young man who has already gained distinction in Germany by his original investigations in connection with tuberculosis and certain of the processes involved in inflammation.

The scope of the present work is to afford to students and physicians a text-book which shall give a short and concise statement of what is known upon the subjects treated, including the results of the most recent investigations.

The book opens with a section of three chapters on malformations. This is condensed and dry; and further, as there are no plates to illustrate the monstrosities, the student wishing to acquire a knowledge of this difficult subject will do better to fall back upon the earlier monographs of I. G. St. Hilaire, Foerster, and Ahlfeld.

Then follow four chapters on the pathology of the blood and lymph, which, though short, are very good, containing essentially what is known upon the subject. Very little space is devoted to thrombosis and embolism; but this is not a neglect on Ziegler's part, as he treats of it in detail in that portion of the book which has not yet been translated.

The succeeding chapters on the retrograde disturbances of nutrition are worthy of much praise, giving as they do a very clear, though concise, account of these changes, including also the results of the latest work on coagulation-necrosis.

The chapter on cysts, consisting of but a single page, is incomplete, and does not treat with sufficient fulness this important subject.

The three chapters devoted to hyperplasia, regeneration, and metaplasia of tissues, give a good account of the somewhat meagre knowledge on these points.

In treating of inflammation, the author gives a short historical sketch of the ideas held at various times upon the conditions present in this process, and then devotes considerable space to the ideas now in vogue, as expressed by Cohnheim, Samuel, and others; the exudation from the vessels, due to presumable changes in the vessel-wall, now forming the anatomical basis. The parenchymatous inflammations of Virchow find no place in the category, nor will Ziegler allow that the connective-tissue corpuscles take any part in the process, as advanced by Virchow, and still maintained by von Recklinghausen.

The secondary changes occurring in the products of an inflammation are well treated; a point in regard to which Ziegler has himself contributed some original work.

The infective granulomata are removed from the category of tumors, and are classed with the inflammations. Under this head are considered tubercle, syphilis, leprosy, glanders, lupus, and actinomycosis.

The anatomy of tubercle and its development are fully and well treated, and the relation of the Bacillus tuberculosis to the disease detailed so far as the present knowledge permits.

Virchow's classification of tumors is adopted, with the exception, as already stated, of the omission of the granulation-tumors. In reference to the aetiology of tumors, the author does not regard Cohnheim's embryonic-foci theory as sufficient to explain all cases, though undoubtedly applicable to many.

Of the increasing importance of the subject of parasites in relation to disease, no better proof is to be found than in the greater number of pages devoted to this point in the newer books; and among the parasites the Schizomycetes claim the lion's share of attention.

The author gives Cohn's classification of the latter, together with a description of their general morphological characters. He then devotes considerable space to a consideration of the conditions, such as temperature, nutritive substances, and the like, favoring their growth; their effect in causing the groups of changes included under the terms fermentation and putrefaction; finally, discusses their relation to disease. Of their method of action, he very properly refrains from expressing an opinion.

The list of pathogenic microbia, according to Ziegler, is a larger one than the strictly cautious observer will admit. For, to go beyond as a proven fact that specific organisms have been found in connection with other diseases than anthrax, relapsing fever, septicaemia of mice, and probably with tuberculosis, glanders, malignant oedema, and, under the Hyphomycetes, actinomykosis, is, in the present state of our knowledge, unwarrantable.

In regard to the mutability of bacteria, the views of various writers *pro* and *con* are given, but no definite conclusion is expressed.

To the Hyphomycetes a chapter is devoted; and, while giving a very good account of what is known in regard to their pathogenic qualities, one can but be impressed with the fact of the extreme meagreness of knowledge of the relation which the ever-present mould-fungi bear to disease.

The chapter on animal parasites contains nothing of special interest.

The book as a whole shows evidence of having been written by a young man. All that is new has special stress laid upon it, while the work of the earlier generation receives less attention. The author inclines to state things positively, with but little of the cautious scepticism which marks the writings of the older and more conservative worker who is prepared to weigh every objection, and combat every point.

This latter quality, however, does not in the least detract from the value of the work, for the object for which it was intended; on the contrary, much enhances it. For nothing can be more disheartening to the student beginning a subject, than to be plunged at first into that mire of doubt which is ever present for him who attempts a deeper insight into a science.

The English translation is a remarkably good one. It is certainly as agreeable as it is rare, to read a smooth translation, where one is not constantly reminded of the tongue from which it had its origin.

The letter-press and wood-cuts are much superior to those usually found in text-books; and Macmillan deserves with Dr. McAlister the thanks of the English-reading profession for presenting Professor Ziegler's work in so attractive and readable a form.

As a text-book for students, physicians, and those men of science who are interested in the sciences upon which medicine rests, it fills a gap which has long been felt.

ECONOMIC ENTOMOLOGY IN ENGLAND.

Report of observations of injurious insects during the year 1882, with methods of prevention and remedy, and special report on wire-worms. By ELEANOR A. ORMEROD, F. M. S, etc. London, 1883. 98 p., illustr. 8°.

THIS is the fourth of a series of reports prepared by Miss Ormerod for the use of the farmers of Great Britain. The plan of these reports is peculiar. They consist largely of abstracts from the writer's correspondence; the greater part of which is presumably in reply to circulars issued by her. In thus collecting and publishing the results of the experience of the more observing agriculturists, Miss Ormerod is doing an important work, and the enthusiasm and energy which she has displayed in it are deserving great praise. It is fortunate, however, that she has not confined herself to the work of compilation, but has recorded the results of personal observations. And we venture to suggest that what she states on her own authority will be read with more interest than the quoted portions of her work. For no one but herself can judge of the relative value of the conclusions of her various correspondents. We realize, however, that the publication of the reports of these correspondents is probably a considerable part of the incentive to their co-operation with her; and the system has produced such good results that one should be slow to criticise it.

The report for 1882 contains notes on more than thirty different species of insects infesting fruit, garden-vegetables, field-crops, and forest-trees. The most serious injury recorded for that year is that to hops by Aphides. It is estimated that the loss to the hop-growers of the United Kingdom from this cause was not less than £1,750,000. This injury is the greatest which has been incurred for many years.

Nearly one-half of the report is devoted to an article on wire-worms, or click beetles. This article was compiled from notes contributed in reply to a circular issued by the council of the Royal agricultural society, and it doubtless gives a very good idea of the popular beliefs now held in the British isles respecting these pests. We wish that the above-named society would now afford their entomologist, Miss Ormerod, an opportunity for directing a series of comparative experiments to test the truth of these beliefs.

The report is well illustrated, partially by some of the well-known figures of Curtis, and partially by original figures drawn by the authoress.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

The elliptic differential equation. — M. Rud. Sturm has here given a method of integration for the general elliptic differential equation $\frac{dx}{\sqrt{X}} \pm \frac{dy}{\sqrt{Y}} = 0$, where X and Y are quartic functions of x and y respectively, say, $X = E(x-a)(x-b)(x-c)(x-d)$, and Y a similar function of y. He shows that this equation can be integrated directly by aid of an integrating factor which he determines. Denoting by $X_{ab} \ldots Y_{ab} \ldots$ the products of two of the factors $x-a, x-b \ldots, y-a, y-b \ldots$, then the left-hand side of the equation $\frac{dx}{\sqrt{X}} \pm \frac{dy}{\sqrt{Y}} = 0$ is made the exact differential of

$$\frac{1}{x-y}\left\{\sqrt{X_{ab}Y_{cd}} \mp \sqrt{X_{cd}Y_{ab}}\right\}$$

by multiplying it by the quantity

$$\frac{1}{(x-y)^2}\left\{[\tfrac{1}{2}(x+y)(a+b) - xy - ab]\sqrt{X_{cd}Y_{ab}} \mp [\tfrac{1}{2}(x+y)(c+d) - xy - cd]\sqrt{X_{ab}Y_{cd}}\right\}.$$

— (*Math. ann.*, xxi.) T. C. [238

PHYSICS.

Electricity.

Efficiency of telephones. — K. Vierordt measures the weakening of sound through telephones by diminishing the sound at the transmitter until it just becomes inaudible at the other end. The sound is measured by the mass and height of a small leaden sphere, which is dropped upon a tin plate. Using two Siemens-Halske telephones, of 205 and 208 S. U. resistance respectively, he found that the loss over thirty-four m. of wire was less than seventy-five per cent of the loss in air. — (*Ann. phys. chem.*, xix. 207.) J. T. [239

Electric lighting. — Ganz & Co. of Budapesth find, that, with a continuous current, the carbon filament of an incandescent lamp gives out first at the end where the positive current enters, a spot of carbon being deposited on the neighboring part of the glass. If alternating machines are used, the life of the lamp is almost exactly doubled, and when the deposit forms it is all around the case. — (*Engineering*, June 15.) J. T. [240

ENGINEERING.

A great 'Sound steamer.' — The steamer Pilgrim, of the Old Colony steamship company, was recently added to the fleet now plying through Long Island Sound. The vessel is the largest and the most expensively fitted up of all steamers which have yet been built for those waters. The hull is of iron, double, and built in compartments. The boiler space is so enclosed by iron bulkheads that the danger of fire is wholly avoided. The engines are of the standard beam-engine type, and fitted with the Stevens valve-gear. They were designed by Messrs. Fletcher & Harrison, and built by Messrs. John Roach & Son. The steering is done by means of a Sickles steam steering gear, and the lighting is performed by Edison dynamos. The hull is 390 feet long on deck, 375 on the load line; the beam is 50 feet over the hull and 87.6 feet over the 'guards;' the depth of hold is 18.6 feet; draught of water, 11 feet. The engine has a steam-cylinder 110 inches in diameter and 14 feet stroke of piston. There are 12 boilers of steel, and calculated for a pressure of 50 pounds per square inch. The total power is estimated at 5,500-horse power. The wheels are of the radial type, and are 41 feet in diameter, weighing 85 tons each. The shafts are 26 inches in diameter. The cylinder weighs 30 tons; the bed-plate, 30 tons; the beam, 33 tons; the condenser, 60 tons. The machinery will weigh, altogether, with water in the boilers, 1,365 tons. There are 103 water-tight compartments; and it is considered that it will be impossible to sink the vessel by collision or grounding. There are 912 electric lamps operated by two Edison dynamos of a total of 11,400-candle power. They are driven by an Armington & Sims engine, built at Providence, of 150-horse power. The grand saloon is the largest in the world: it is 350 feet long, and accommodates 1,400 passengers, for whom state-rooms are provided. — (*Sc. Amer.*, June 30.) R. H. T. [241

CHEMISTRY.

(*General, physical, and inorganic.*)

Apatites containing iodine. — In continuing the study of the formation of artificial apatites, A. Ditte fused baric iodide with a mixture of sodic iodide and ammonic phosphate, the latter in small quantity. On slow cooling, the mass crystallized in hexagonal prisms of the composition $BaI_2 . 3 Ba_3(PO_4)_2$. When ammonic arseniate was substituted for the phosphate, the corresponding iodarseniate, $BaI_2 . 3 Ba_3(AsO_4)_2$, was formed. The iodvanadate, $BaI_2 . 3 Ba_3(VO_4)_2$, crystallized in transparent prisms. The strontium compounds, $SrI_2 . 3 Sr_3(PO_4)_2$, and $SrI_2 . 3 Sr_3(AsO_4)_2$, and calcic iodvanadate, $CaI_2 . 3 Ca_3(VO_4)_2$, were obtained. — (*Comptes rendus*, xcvi. 1226.) C. F. M. [242

The spectrum of beryllium. — Mr. H. N. Hadley finds that the spectrum of beryllium shows no marked analogy with the spectrum of calcium, magnesium, or aluminum. It does not resemble the spectrum of carbon, boron, or silicon; but it is more closely allied to that of lithium. The author therefore concludes that it is the first member of a dyad series of elements homologous to calcium, strontium, and barium. — (*Journ. chem. soc.*, June, 1883.) C. F. M. [243

Decomposition of water by the metalloids. — When distilled water is boiled with sulphur, C. Z. Cross and A. F. Higgin find that it is decomposed according to the equation $2\,H_2O + 3\,S = 2\,H_2S + SO_2$. They also noted that sulphur distilled with steam or with the vapor of dilute alcohol. On boiling arsenic with water, it was converted into arsenious acid and hydric arsenide. Arsenious sulphide was changed into a sulfoxy-compound. — (*Berichte deutsch. chem. gesellsch.*, xvi. 1195.) C. F. M. [244

Pyronome. — This is the name given by M. Sandoy to a new explosive, consisting of sixty-nine parts of saltpetre, nine of sulphur, ten of charcoal, eight of metallic antimony, five of potassium chlorate, four of rye-flour, and a very small quantity of potassium chromate. The materials are mixed with an equal quantity of boiling water, and the mass is evaporated to a paste, dried, and powdered as wanted. This mixture is said to be much cheaper than dynamite, but its manufacture and use must be attended with considerable danger. — (*Chem. techn. rep.*, 1883, 154.) C. E. M. [245

METALLURGY.

Gaseous fuel in iron manufacture. — Mr. W. S. Sutherland read a paper before the British iron and steel institute, on the production and utilization of gaseous fuel in iron manufacture, in which he claims that the seams of boilers can be welded instead of riveted, if the heat can be applied uniformly, and of sufficiently high temperature, without excess of air or admission of dirt. This kind of heat he has obtained only by the use of coal-gas, Siemens-producer gas, or water-gas, the preference being given to the latter. To secure the requisite air in constant proportion, the gas being in excess, gas and air are mixed before combustion; probably the first instance of such a utilization of the principles of a Bunsen burner on a large scale. Explosions are prevented by having an outlet lightly covered by india-rubber, at some corner of the main; and when the wave, or disk of flame, which does not readily turn a corner, reaches this cover, it breaks the rubber just as a blow would. The method has been worked some ten years without accident. From all his experience, Mr. Sutherland concludes, that to produce a good, true, wrought iron, Siemens gas with varying proportion of air, instead of air alone, should be blown into the iron in the Bessemer converter. — (*Eng. min. journ.*, July 14, 21.) R. H. R. [246

Nickel extraction. — Prat and Laroche of Bordeaux add powdered nickel ore to a bath of sulphuric acid 56° to 66° Baumé: on stirring the mass it becomes heated, and in half an hour it is nearly solid. The soluble salts of the metals, thus formed, are leached out with boiling water. From this solution, oxalate of nickel is formed by boiling with oxalic acid; the precipitated oxalate of nickel is boiled with caustic soda, yielding oxide of nickel and oxalate of soda. The oxalic acid is recovered from the latter salt. — (*Eng. min. journ.*, June 2.) R. H. R. [247

The Doetsh copper extraction process. — This process has been in use by the Rio Tinto mine for some years. The ore is crushed to .4 inch in size, and piled in heaps forty-five feet wide, with suitable channels at the bottom, and vertical draught-holes. About two per cent of salt is sprinkled over the top. A basin thirty feet square is made on the top of the heap, and the regenerated liquors from the last operation are run into it. The dissolved and leached copper is precipitated by scrap iron, the iron liquors remaining are regenerated by sprinkling them down through a coke tower, while mixed chlorine and hydrochloric acid are forced upward. — (*Eng. min. journ.*, July 14.) R. H. R. [248

MINERALOGY.

Picro-epidote. — MM. Damour and Des Cloizeaux have investigated a gray crystalline mineral from Lake Baikal, and found it closely related to epidote in crystalline form and optical properties. A complete chemical analysis was not made; but qualitative tests proved it to be a silicate of alumina and magnesia, with only a trace of calcium. It is supposed to be a magnesium epidote, and the name 'picro-epidote' is proposed for it. — (*Bull. soc. min.*, vi. 23.) S. L. P. [249

Jeremeieffite. — A new mineral from the Soktoui, south-east of Adun-Tschilon in western Siberia, has been described by M. Damour. It occurs in nearly colorless, transparent, hexagonal prisms, thus resembling some varieties of beryl and apatite. Hardness, 6.5; specific gravity, 3 28. Qualitative analysis proved it to be essentially a borate of alumina. Before the blowpipe it is infusible, loses its transparency, and colors the flame green (boron); with cobalt solution, it assumes a blue color. It is insoluble in acids, except after strong ignition, when sulphuric acid dissolves it. Chemical analysis yielded B_2O_3, by difference (40.19) . Al_2O_3 (55.03) . Fe_2O_3 (4.08) . K_2O (0.70) = 100%, from which the formula $(Al, Fe)_2\,B_2O_6$ is derived. It is named after the Russian mining engineer, Mr. Jeremejew. — (*Bull. soc. min.*, vi. 20.) S. L. P. [250

METEOROLOGY.

Bavarian meteorology. — The quarterly publications of the meteorological stations in Bavaria deserve special mention for the model way in which the observations are recorded, and for the excellent discussions which accompany them. The concluding number of the series for 1882 contains a monograph by Dr. Lang upon the observations at Munich for sixty-seven years. Among the results reached is that the mean pressure for any day can be better obtained by taking the mean of the observations at six A.M., two and ten P.M., than by any other of the eight different combinations tested. The mean of the maximum and minimum for the day gives in general nearly as good a result. Similarly of the temperature, the best combination is the mean of the seven A.M., two and nine P.M. observations, but the mean of the maximum and minimum is nearly as good. — (*Beob. met. stat. in Bayern*, iv. 4.) W. U. [251

Rainfall at Hawaii. — The meteorological conditions of the island of Hawaii are so peculiar, that, though the island is not large, in one portion rain seldom falls, and the land is a desert; while in another the rainfall is so excessive that it is said it should be measured, not in inches, but in feet. In proof of the excessive rainfall, the following figures have been furnished by Dr. C. S. Kittredge of Hilo, Hawaii. The observations were made by Dr. Wetmore at Hilo.

Rainfall at Hilo, Hawaii.

	1880.	1881.	1882.	1883.
	In.	In.	In.	In.
January	–	5.1	36.7	3.1
February	–	3.1	23.6	23.1
March	–	55.2	18 7	2.4
April	14.5	8.3	5.2	12.4
May	6.9	4.2	7.0	–
June	8.1	10 8	7.1	–
July	22.1	9.9	7.9	–
August	7.3	8.8	7.0	–
September	14.5	8 2	8.6	–
October	15.7	4.9	6.9	–
November	3.6	21.7	20.4	–
December	3.1	34.2	15.7	–
Sums.	–	174.4	164.8	–

For the three years April 1, 1880 to April 1, 1883, the total amount is 463.6 inches, averaging 154.5 inches each year. — W. U. [252

GEOGRAPHY.

(*Arctic.*)

North-west America. — Reports from the island of Kadiak, Alaska, state that the spring has been unusually late, and on the 6th of June summer seemed to have just set in. During the preceding three months, the rainfall had averaged eleven inches per month. Salmon-canneries had been established at Karluk, on the island of Kadiak, and at Seal bay, Afognak island. On Cook's inlet, a cannery had been established at the Kassilax river. Exploring parties were examining the shores of the inlet for minerals. One party was ascending the Sushitno river, where Doroschin reported gold many years ago. Another party had sailed for Kamishak bay, Aliaska peninsula. An experiment in sheep-raising has been going on, on the island of Kadiak, for three years. Success seemed certain, as the wool improved in quantity and quality, and was free from burrs and impurities. In adding to the number, an epidemic disease was introduced; and of the flock of three hundred, only about thirty survived. —— Rev. S. Hall Young has been making a study of the religious belief of the T'linkit Indians of the Alexander archipelago, which will shortly be made public. —— The U. S. revenue-steamer *Corwin* left Sitka on her Arctic cruise, June 16. —— At Juneau City, the largest shipment of gold-dust ever made was sent by the June steamer. The troubles among the miners here have caused many to depart. It appears that the rock containing the gold is of a loosely crystalline or granular nature, which weathers to a gravel. The lighter portions of this wash away in the rains; but the gold settles down into the remainder, which becomes much richer than the original rock in equal quantities. This gravel is said to exist on the upper parts of the auriferous mountain-belt. Prospectors claim this gravel as placers, and desire to work it under the law governing placer-mining. The companies who have taken up quartz-claims desire to have it regarded as quartz or vein mineral: hence the conflict, which was to have been settled by the officers of the U. S. S. *Corwin*. The decision has not been made public. —— Prospectors have gone to explore the country about Yakutat bay, where the Indians have hitherto been hostile. Reports as to its richness in gold have long been prevalent; but so many have met their death from the natives, that hitherto no one has dared attempt exploration. The party consists of five men, with six months' provisions, and was transported by the U. S. S. *Adams*. The prestige of the naval vessel, it is hoped, will afford them protection. —— The schooner *Alaska* has sailed from San Francisco, for Golovine sound, Alaska, taking with her a small stern-wheel steamer and a complete mining equipment and some twenty-five miners. The mines are situated on the Fish river, which forms part of the water-communication between Grantley harbor and Golovine sound. It is stated that the ore is a very rich argentiferous galena. The parties engaged in the enterprise have been several years investigating the deposit, and feel sufficiently encouraged to begin a regular prosecution of the business. In this vicinity, graphite is known to occur in a sienitic rock, in considerable quantities. This will be the most northern mine actually worked in the western hemisphere. — W. H. D. [253

(*South America.*)

Bove's new expedition. — Lieut. Bove proposes a new expedition to complete studies begun during his last journey in the southern part of the Argentine republic. He proposes to investigate the present physical and economic condition of the country, with a view to closer commercial relations with Italy. He will take up the exploration of Patagonia and Tierra del Fuego, especially the basin of Santa Cruz, the canals of western Patagonia, and the habitable country extending from the Ona to the Cioniu Chonos. The inhabitants are totally unknown. The explorer has placed himself at the disposition of the Argentine government for the purpose of placing light-houses on Staten island and other points needful for navigation, an arrangement which will facilitate the prosecution of his other investigations. For transportation he will depend partly on the English missionary board, who have promised co-operation, and will afterward equip for exploration one of the small vessels always obtainable for such purposes either at the Falkland islands or Punta Arenas. The journey will occupy a year, and cost about five thousand dollars. — (*Revue géogr.* June, 1883.) W. H. D. [254

BOTANY.

Ellis' North American fungi. — Dr. Farlow, who edited the third and, in part, the eleventh century of this collection, contributes valuable notes on some of the Peronosporeae and Uredineae so far distributed, with some pertinent remarks on the nomenclature of the latter group. Though desirous of retaining the earliest specific names wherever practicable, the writer does not believe, with Winter, in applying the name given to the Aecidium of a Puccinia or other teleutosporic form to the species, when its several stages are grouped under the generic name of the latter form. "For practical reasons, if for no other, the custom of substituting an aecidial specific name, for a name given to a Uredo or teleutosporic form, should by all means be avoided. Of all the Uredineae described by older writers, probably none are more difficult to determine satisfactorily at the present day than the species of Aecidium, so called. Original specimens of that genus are, as a rule, not so well preserved as those of other genera of the order; and, if one usually gets little satisfaction from examination of what is left of the original types, he is scarcely better off on reading the older descriptions. It was not unfrequently the habit of older mycologists, to describe as varieties of one Aecidium forms found on the most diverse plants; and most certainly it is going too far to substitute for the name of a Puccinia, let us say, which has passed current for many years, the name given by an old authority, like Persoon or Link, to what he considered a variety of an ill-defined Aecidium. It cannot be said that any want of respect to the older writers is shown by abandoning their aecidial names in such cases."

With respect to the Uredo name, however, the case is held to be somewhat different. "As a matter of fact, the types of the earlier-described Uredo forms are much better preserved than Aecidia, and examinations of older herbaria frequently enable one to determine with accuracy what form was meant by an older author. Furthermore, the Uredo and teleutosporic forms frequently are found together in the same sorus, or in close proximity; and examinations of authentic specimens often show the relation of an old-described Uredo to a more recently described teleutosporic form. The most important consideration, however, is the following. Many of the forms now recognized as teleutosporic have one-celled spores, and were originally described as forms of Uredo; and, in such cases, one must go back to the original specific names." He adds, however, "If I have advocated retaining the older Uredo name in cases where we know with certainty what was meant by the earlier mycologists, I have by no means intended encouraging the use of names about which there is doubt, either from the absence of typical specimens, or confusion of several species by older writers. Rather than favor that method — if one may say so — of forcing priority, I should prefer to give up the substitution of all old Uredo names, except, possibly, in the case of species now referred to Uromyces." The use of the parenthesis for the original authority for the species, though somewhat cumbrous and generally discarded by phenogamic botanists, is, on the whole, advocated, especially since the genera of fungi are often not very definitely fixed. "A species of Fries, for instance, may, during five years, be dragged through no one knows how many new genera; and it is with a mildly malicious satisfaction that one sees those modern writers who adopt minute generic subdivision, forced by the prevailing custom to add the '(*Fr.*)' as a slight tribute to the past."

Besides the characters of eight species, previously nondescript, the notes also contain much critical information concerning the synonymy of many of the species, and the geographical distribution of others. An interesting fact is the preponderance, among our Peronosporae, of species germinating by the production of zoöspores, though this would appear to better adapt them to an insular climate than to ours, which is a continental one, subject to extremes of heat and moisture. — (*Proc. Amer. acad.*, May 9, 1883.) W. T. [255

ZOÖLOGY.

Crustacea.

Parasite of the salmon. — Carl F. Gissler in an anonymous article, in the *American naturalist* for August, describes and figures, as a new species of Caligus, a parasite of the salmon of Puget sound. The species is probably Lepeophtheirus salmonis, which infests the salmon upon both sides of the North Atlantic. — S. I. S. [256

Brachyura and Anomura off the coast of New England. — In a preliminary report on the Brachyura and Anomura dredged in deep water off the south coast of New England by the U. S. fish commission in 1880–82, S. I. Smith enumerates thirty-one species taken in sixty-five to six hundred and forty fathoms, and gives full descriptions and figures of the new forms discovered. The report, although only a supplement to a notice of the crustacea dredged in the same region in 1880, describes three new genera and seven new species. Of the thirty-one species enumerated, only four were known from the south coast of New England previous to 1880, and more than half of the whole number were new to science; and yet none of the species belong to the abyssal fauna proper, and nearly all of them were taken most abundantly in less than two hundred fathoms. The dredgings off Martha's Vineyard in 1882 revealed the total, or almost total, disappearance of several of the larger species of crustacea, which were exceedingly abundant, in the same region, in 1880 and 1881. The disappearance of these species was apparently connected directly with the disappearance of the tile-fish (Lopholatilus) from the same region; and on this account complete tables are given of the specimens examined from all the dredgings in the region in question. Five species, which were exceedingly abundant in 1880 and 1881, were not found, or found only very rarely, in 1882; and five others, taken several times in 1880 and 1881, were not taken at all in 1882. These species were specially characteristic of the narrow belt of comparatively warm water, — in sixty to one hundred and sixty fathoms, — which has a more southern fauna than the colder waters either side. Professor Verrill has suggested that there was a great destruction of life in this belt in the winter of 1881–82, caused by a severe storm agitating the bottom-water, and forcing outward the cold water that occupies the great area of shallow sea along the coast, thus causing a sudden lowering of the temperature along the warm belt.

Among the forms described are two new genera of Galatheidæ, in one of which there are no appendages on any of the first five abdominal somites of the adult male. But the most interesting forms are two genera of hermit-crabs, — Parapagurus and Sympagurus, — in which the branchiae present types of structure intermediate between the phyllobranchiae of ordinary paguroids, and the trichobranchiae of the Astacidae, etc. — (*Proc. nat. mus.*, vi., June, 1883.) S. I. S. [257

VERTEBRATES.

Development of muscle fibres and their union with nerves. — Although very numerous researches have been made on the differentiation of striped muscles, and on the termination of their motor nerve-fibres, yet the multifarious observations have often been too incomplete to lead to any but conflicting and unsatisfactory theories. An important contribution toward reducing this unfortunate and excessive confusion to order is made by L. Bremer, who has studied the post-embryonic changes in lizards, frogs, and mice. The nucleus of the muscle-fibre, together with the protoplasm surrounding it, constitutes the so-called muscle-corpuscle; the corpuscle is much more prominent in young than in old muscles, for its protoplasm is gradually differentiated into muscular substance; a small number of corpuscles enters into the formation of each fibre; the substance of the muscle forms a network, which was first partially recognized by Heitzmann (*Wien. sitzungsber.* xvii. abth. 3, 1873); the meshes of this network appear polygonal in transverse, rectangular in longitudinal sections; the network is a modification of the protoplasmatic network of the corpuscles, and is so arranged that there are alternating rows, both transverse and longitudinal, of fine knots and large knots (corresponding to the fine and broad striae); the fine knots are connected by fine threads, and the large knots by coarse threads; hence there is a fine and a coarse net.

The post-embryonic multiplication of fibres takes place by means of the structures described by Margo (*Wien. sitzungsber.* xxxvi. 229) under the name of 'sarcoplasten;' there are lines or chains of muscle-corpuscles, united by the protoplasm net, and derived by proliferation from the corpuscles of the original fibres; the sarcoplast gradually separates from the parent fibre, undergoing muscular differentiation meanwhile, and also becoming connected with the nerve. The growth of the fibre is initiated by a multiplication of the corpuscles; the sarcolemma is not present at first, but appears later, being probably formed by the fused cell membranes of the corpuscles, to which appears to be added a coat of connective tissue, and also around the motor plate between the two sarcolemmic coats, an extension of Henle's sheath of the nerve.

The motor nerve plates are formed as follows: When the sarcoplast begins to change to muscle, the nerve grows towards it until the two meet and unite. In lizards only a single nerve-fibre, in the frog and mouse several together, thus approach the future muscle. At the point of contact, the muscle-corpuscles change, so that an accumulation of protoplasm and a proliferation of nuclei occur there. These accumulations were first described by Kühne under the name of 'muskelspindeln' (*Virchow's arch.*, 1863, 116), and are mentioned by many subsequent writers: Bremer now shows that they are young 'end-plates.' Into these the ramifications of the nerve penetrate, after the medullary sheath has been lost. The details of the process, of course, vary in different animals, as do also the final forms of the motor plates.

Besides the motor terminations, there are others, which the author believes to be probably those of the sensory nerves. The fibres running to them are either small and medullated, or naked and end in ramifications upon the muscle, without any conspicuous collection of nuclei and protoplasm at the place of junction. The smaller nerve endings occur on the same fibres with the motor plates, and probably both exist on every fibre. The smaller endings, Bremer designates as 'enddolden' in contradistinction to the 'endplatten.' (Sach's paper on the sensory nerves of muscles is not cited by Bremer.)

Hensen has advanced the view that the connection between the nerves and the peripheral cells exists from the first in the embryo, and that, as the cells divide, so do the nerves. Bremer's observations show that with muscles this is not the case. Moreover, Kleinenberg's theory of the evolution of muscle and nerve must be at least modified, if not set aside. (That the union of the nerve-filament with the peripheral organ is secondary, is shown also by His. SCIENCE, i. 956.) — (*Arch. mikr. anat.* xxii. 318.) C. S. M. [258

ANTHROPOLOGY.

Folk-lore in the Panjâb. — Mrs. F. A. Steel is collecting the folk-stories among the natives in the Panjâb. No. 18 is a charming shepherd-tale common among the cattle-drover's children in the forests of the Gujrânwâlâ. It is about Little Ankle-Bone. Once upon a time a little shepherd was eaten by a wolf, that hung the ankle-bone of his victim to a tree. Some robbers, dividing their spoil, were startled by the falling of the bone, which became a little lad, and did many wonderful things, taming all the beasts of the field, and fowls of the air. He changes a pond into milk, by the side, of which he sits under an oak-tree, playing his shepherd's pipe, while all the animals come to listen, and to drink out of his marble basins. The series will be continued. — (*Indian antiquary*, xii. 105.) J. W. P. [259

Lorillard City. — After his researches at Chichen-Itza, M. Charnay made an excursion into the country of the Lacandones, — a fierce, indomitable tribe, of whom it is most desirable to have more information.

M. Charnay found the ruins of an ancient city, which he named after his generous patron. In his explorations here, he was assisted by a young Englishman, Mr. Alfred Maudslay, with whom he shares the honor of discovery. The town is about 17° N., on the left bank of the Usumacinta, on the boundaries of Guatemala and the two Mexican provinces of Chiapas and Tabasco. The ruins resemble those of Palenque in the material, arrangement of interiors, decorations, and glyphs. The great stone slabs of Palenque carved with inscriptions and bas-reliefs, are replaced here by lintels covered with superb sculpture (cf. i. 1008.) — (*Proc. roy. geogr. soc.*, v. 44.) J. W. P. [260

Shaking towers. — Col. Lovett, in his journey through northern Persia, visited the shrines of some dervishes, near which is a minar, curious for possessing the same property that makes the shaking towers of Ispahan famous. When shaken by a man standing on the top, it oscillates sufficiently to cause a brick placed on the edge of the cornice to fall. It is about thirty-five feet high, and six feet diameter at the base, tapering gently upwards. This property of vibrating is attributed at Bostam, as it is at Ispahan, to miraculous interposition of the local saint. It is, of course, due to the elasticity of the bricks and cement used, the latter becoming more elastic with age. — (*Proc. roy. geogr. soc.*, v. 80.) J. W. P. [261

Explorations in Guatemala. — Mr. A. P. Maudslay, mentioned in M. Charnay's researches, has published separately some of his own personal explorations, with a map and ground-plans. Starting from Livingstone, Guatemala, he first visited Quirigua, whose ruins consist of raised mounds and terraces, usually faced with stone, and near to these, carved monoliths. The latter are of two kinds: high upright stones, ornamented with human figures and tables of hieroglyphics; and low broad stones, in the shape of some animal. The first named measure three to five feet across, and 12 to 25 feet out of the ground. On both back and front, the principal ornament is a human figure in relief, decked out in the barbaric splendor usual throughout Central America. Mr. Maudslay suggests that the inevitable human face on the thorax may explain the function of the great number of masks from this quarter. The second class of carvings is very interesting. One specimen, weighing about eighteen tons, represents a turtle having a human head, with projecting ears richly ornamented. In place of the tail is the life-sized figure of a woman sitting cross-legged, and holding a manikin sceptre in her hand. The whole surface of the block is profusely ornamented. Nowhere in the neighborhood are there traces of houses. The exploration at Quirigua led to an attempt to fix the site of Chaciyal, mentioned by Cortez.

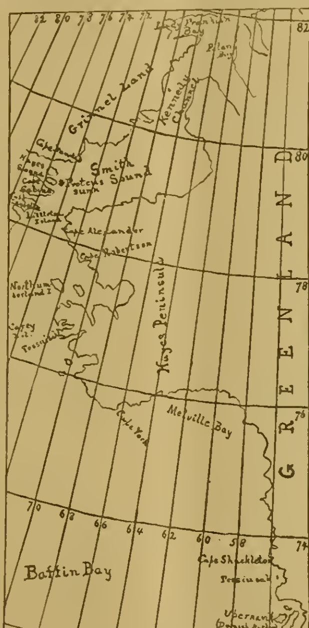
Leaving this spot, Mr. Maudslay visited Copan, where the sculptures impressed him as being above those of Quirigua in execution. From Copan our traveller wandered next to Tikal, north-east of Lake Peten, only once before visited by a foreigner, Bernouilli. All the houses here are built of stone, and coated with plaster. Inside, the walls are seven to eight feet high, and the stone roof forms a narrow gable. The rooms within are very narrow, resembling long passages. The town was laid out in a rectangular form, the slopes terraced with sustaining walls. The houses are often built on raised foundations, stone-faced in the same manner. The most imposing buildings are the five temples raised on pyramidal foundations, in front of which are steep stairways leading up to the doors of the temples. There is no trace of any idol or object of worship in these buildings, but carved slabs and circular altars are found in the plaza. The next point of interest was a ruined town on the Usumacinta. On the top of a steep bank 60 feet high stands the first row of houses, and the town is built on a succession of stone-faced terraces reaching more than 250 feet in height. Instead of the long, narrow interiors as at Tikal, the houses are broken into a number of recesses by buttresses supporting the roof at intervals, and stone is used instead of sapote-wood for lintels. One of the houses at Usumacinta is minutely described by Mr. Maudslay. In nearly all the houses, around the idols, stand earthen pots partly filled with some resinous substance, which the Lacandon Indians probably placed there, showing that the old faith has not died out. At this point Mr. Maudslay met M. Charnay. This very important paper closes with a short sketch of the Lacandones. — (*Proc. roy. geog. soc.*, v. 185.) O. T. M. [262

NOTES AND NEWS.

News of a serious character has been received from the Greely relief expedition. The Proteus and Yantic sailed from St. Johns, Newfoundland, June 29. They arrived safely at Disco on the 6th and 12th of July respectively. The Proteus with Lieut. Garlington and the relief party, with supplies, etc., sailed from Disco for Cory island, arriving on the 16th. On the 21st she started for Smith sound, and reached a point in latitude 78° 52′, longitude 74° 25′ W., a few miles north and west of Cape Sabine, where she was beset and crushed in the pack. The party succeeded in saving boats and provisions sufficient to sustain them during their retreat, and made their way across Smith sound and along the eastern shore to Cape York, and reached Upernavik on the 24th of August, all well. Records had been left at Littleton island which apprised the Yantic, on her arrival, of the disaster. A search was immediately instituted, and on reaching Upernavik, Sept. 2, it was found that the Proteus party, after suffering severe hardships, and traversing six hundred miles of the Arctic sea, had arrived in safety. No news was obtained of the Greely party, no supplies had been landed for them, and their situation must be considered as grave. Some rumors had reached the Danish settlements by parties of Eskimo, which, however, are not to be considered as of any weight; and there is yet no reason for supposing that any ill fortune, further than the loss of anticipated supplies, has befallen Lieut. Greely and his companions. The failure to land supplies was probably due to the conditions of the ice at Littleton island, but nothing can be stated with certainty in advance of more explicit information. The Yantic, with the rescued party, arrived at St. Johns, Sept. 13.

— At a meeting of the Scottish meteorological society, July 26, the following scheme, according to *Nature*, was adopted, looking to the establishment of a zoölogical station in the Firth of Forth: —

It is proposed to enclose the Granton quarry, which has an area at high water of about ten acres, and depths varying to sixty feet, so as to regulate the inflow and outflow of the tide in such a manner, that, while admitting abundance of sea-water at each tide, fish and other animals will be prevented from escaping out of the enclosure. This will be done by means of stakes and wire, with other kinds of netting. The quarry will then be stocked with all kinds of fish and marine invertebrates. When it is desired to separate fish or other animals for special study, this will be done by floating or fixed wire and wood cages.



A barge about sixty-four feet by twenty-seven feet, of great stability, will be moored in the enclosure; upon this will be built a house with laboratories, workrooms, and a library; it will also be furnished with a small windmill to pump up sea-water into a tank on the roof. The water in this tank will be conveyed by pipes to the various tiled tables, glass jars, and aquaria of the establishment. A small cottage will be built on the shore for the accommodation of the keeper and engineer, with one or two spare rooms. A steam pinnace for dredging and making observations in the Firth of Forth and the North sea will be attached to the station.

A naturalist will be appointed whose duty will be to make continuous observations and experiments, assisted by the engineer and keeper. There will be ample accommodation for four other naturalists to work at the station, and carry on investigations; and, so far as the accommodation will permit, British and foreign naturalists will be invited to make use of the station free of charge.

Towards the carrying-out of this scheme, the Duke of Buccleuch has liberally granted a lease of the quarry at a nominal rent, with permission to erect a cottage on the shore. A gentleman who takes a warm interest in the progress of research in Scotland has offered 1,000 *l.* to construct the barge, and fit it up with laboratories and workrooms. Mr. J. Y. Buchanan has promised to fit up one of the rooms on the barge as a chemical laboratory suited to the requirements of the station; Mr. Thomas Stevenson, the society's honorary secretary, has agreed to give his professional services in enclosing the quarry gratuitously; and Mr. John Anderson has undertaken to provide the station with a salmon and trout hatchery. Mr. John Murray will furnish the laboratories with apparatus, and place his large zoölogical library at the service of workers. A number of gentlemen have promised to support the undertaking when once commenced; and it is expected that within a few months the station will be presented with a steam-pinnace and with funds for the erection of a cottage on the shore, — the only desiderata to complete the scheme.

The society granted three hundred pounds for the first year, and two hundred and fifty pounds each for the two succeeding years, toward the expenses of the station. It is expected that by the beginning of November the proper work of the station will be begun. Already several distinguished naturalists have signified their intention to avail themselves of the altogether unique facilities which will be afforded by this zoölogical station for the successful prosecution of biological research.

— In a report on the mineral resources of the United States, during 1882 and the first half of 1883, shortly to be published by the U. S. geological survey, Mr. Albert Williams, jun., has compiled a series of special statistics, of which the following totals will be of interest to our readers.

Omitting the local consumption, there were mined 43,130,863 tons of Pennsylvania anthracite, and 87,963,038 tons of other qualities of coal, including a small amount of anthracite won outside of Pennsylvania; the respective colliery values being $97,044,442 and $109,953,797. Of iron, 1,350,000 tons were mined, worth $44,775,000; while there were consumed in all the iron and steel works, including furnaces, 5,610,000 tons of anthracite and 9,740,000 tons of bituminous coal, 5,130,000 tons of coke, 145,750,000 bushels of charcoal, and 5,800,000 tons of limestone. The product of gold is estimated at $48,750,000, and of silver at $70,200,000. In other words, the mint value of the precious-metal product was $88,048,239 less than the colliery value of the coal produced during the same eighteen months.

Of crude petroleum, 41,415,163 barrels, valued at $35,010,476, were produced, — a diminishing product with an increasing value; while 149,646,232 pounds of copper were mined, valued in New York at $24,538,091, — an increasing product with a diminishing value.

The lead product was 202,890 tons, worth in New York $18,924,550; and of zinc, 51,765 tons, valued at $5,311,620. 75,472 flasks, or 5,873,508 pounds, of mercury were produced, worth in San Francisco $2,100,750. Of nickel, the product in 1882 was 281,616 pounds, worth $209,777, but the reduction-works closed in 1883; while of cobalt, ore and matte, the product for 1882 was valued at $15,000.

Of other metals, there were mined in 1882, 3,500 tons of manganese, with a spot value of $52,500; 2,500 tons of chromium, worth in Baltimore $100,000; and 60 tons of antimony, worth about $12,000. It is stated that a trifling amount of tin ore has been mined, and the production of metallic tin on a small scale begun.

The estimated value of the building-stone quarried in 1882 is $21,000,000; grindstones, $700,000; soapstone, $90,000 (6,000 tons); brick and tile made, $34,000,000; whiteware, $5,000,000; lime, $21,700,000 (31,000,000 bbls.); cements, $3,672,750 (3,250,000 bbls.); pumice quarried, $1,750 (70 tons); phosphates dug, $1,992,462 (332,077 tons); marl, $540,000 (1,080,000 tons); mica, $250,000 (75,000 lbs.); barytes, $160,000 (20,000 tons); asbestus, $36,000 (1,200 tons); and asphaltum, $10,500 (3,000 tons). There were further produced in 1882 and 1883, 9,618,569 barrels (2,693,196,520 lbs.) of salt, valued at $6,480,210; 2,100,750 pounds of borax, worth $562,903; and in 1882, of sodic carbonate, over 1,600,000 pounds; and of copperas, 15,000,000, worth $112,500.

The value of precious stones found in 1882 was, before cutting between $10,000 and $15,000; after cutting, between $50,000 and $60,000. And there were mined 500 tons of corundum, valued at $6,250; 75,000 tons of quartz; and in 1882 and 1883, 687,500 pounds of graphite, worth $55,000.

The total value of the metals produced in the United States, during 1882, is estimated at $219,756,004; and of the non-metallic mineral substances, $234,156,402: making the total mineral product $453,912,406.

No data seem to have been obtained regarding many of the minor mineral products, while in the majority of cases the figures appear to be approximations only. These defects can doubtless be remedied, in the future, by the adoption of better laws and methods for the collection of our mineral statistics.

— Hachette publishes a book of travel by Edmond Cotteau, entitled 'De Paris au Japon à travers la Sibèrie.' It is well illustrated, and, apart from the illustrations, is especially valuable as indicating how unchanged and identical the civilization of old Russia, as seen in Moscow and similar cities, has been transplanted, as it were bodily, to successive and numerous localities stretching from the Ural to the Pacific, and to the borders of the Arctic Sea.

— A dainty and unique little book is published by Charles F. Lummis of Chillicothe, O. It is a miniature quarto, 6.5×7.5 cm. in size, made of twelve leaves cut from the thin paper-like layers of birch bark. Appropriate woodcuts cover the slightly thicker outer pages, while the interior is given to 'Birchbark poems, vol. ii.,' by the publisher. We cannot say much for the eight little 'poems,' of which only the first, on 'silver-birches,' has any special appropriateness; but the setting is excellent and attractive, and reflects well the taste and skill of the author.

— The *Manchester guardian* of July 18 gives the following report of M. Pasteur's speech at Dôle on July 14, when his fellow-townsmen placed a memorial tablet in the wall of the house in which he was born. The tablet says simply, "Here was born Louis Pasteur, Dec. 27, 1822." M. Pasteur's remarks were as follows: "I am deeply touched by the honor which the town of Dôle has conferred upon me; but permit me, while expressing my gratitude, to deprecate this excess of glory. In rendering to me the homage which is usually rendered only to the illustrious dead you encroach too hastily upon the judgment of posterity. Will it ratify your decision? And ought not you, Mr. Mayor, to have prudently warned the municipal council against so hasty a resolution? But, having protested against this outburst of an admiration which I do not merit, permit me to say that I am touched to the bottom of my heart. Your sympathy has united in this commemorative tablet two great things which have been at once the passion and the charm of my life, — love of science, and reverence for the paternal home. — O my father and my mother! O my dear departed, who so modestly lived in this little house! it is to you that I owe all. Your enthusiasms, my brave mother, you transmitted them to me. If I have always associated the greatness of science with the greatness of the country, it was because I have been full of the sentiments with which you inspired me. And you, my dear father, whose life was as rude as your rude trade, you showed me what patience and sustained effort could accomplish. It is to you that I owe the tenacity of my daily work. Not only had you the persevering qualities which made life useful, but you had an admiration for great men and great things. 'Look above, learn there, seek to rise always,' — this was your teaching. I see you again after your day's labor, reading some story of battle from a book of contemporary history which recalled to you the glorious epoch which you had witnessed. In teaching me to read, it was your care to teach me the greatness of France. Be blessed both of you, my dear parents, for what you were; and let me transfer to you the homage which is today bestowed upon this house. — Gentlemen, I thank you for giving me the opportunity of saying aloud what I have thought for sixty years. I thank you for this celebration and for your reception; and I thank the town of Dôle, which does not forget any of its children, and which has borne me in such remembrance." M. Pasteur's father was a tanner.

SCIENCE.

FRIDAY, SEPTEMBER 28, 1883.

THE NATIONAL OBSERVATORY.

We call the naval observatory at Washington 'national,' not because we would ignore its recognized official title, but because we wish to emphasize the facts, so often lost sight of, that it is the property of the nation, that it is the only observatory of the first class which the nation possesses, and that its operations should be equally available for every department of the government. Such an institution is a national one, by whatever name it may be called; and the question of its direction and supervision is one of interest to every government office having need of such astronomical observations as can be made only at a fixed observatory. The general principle that it should be under purely scientific control is one that has generally been conceded in the abstract, but has not always been acted upon. Sears Cook Walker, who, thirty-five years ago, was perhaps the most eminent astronomer of America, propounded this principle in a published letter; but Maury was then near the zenith of his power, and little notice was taken of the opinion of the subordinate. From that time to this, the superintendency has remained in the hands of line-officers of the navy. The officers of our navy are of too high a character, and have too much self-respect, to pretend to a knowledge which they do not possess: we may therefore inquire how it happens that they claim the exclusive direction of an establishment most of whose operations are outside the line of their professional qualifications. Secretary Chandler has never given official utterance to his views; but he is understood to have said that he did not feel authorized to deviate from a precedent which had been sanctioned by forty years of usage. Precedent is, in one form or another, the basis of the principal argument on which the present system is sustained: we shall therefore inquire whether it has any real validity.

In order that such a supposed precedent may afford any sound reason for its continuance, the system must have resulted from the matured judgment of his predecessors, whose acts the new secretary followed. Unless this was the case, unless he was doing what they would have done under the same circumstances, the argument could have had no legitimate weight. Now, if one looks more closely at the case, he will see that there is a great deal of precedent on the other side. With one exception, not a superintendent had ever been appointed before his time who was not a professional astronomer, or had not some standing in the scientific world. Maury, Gilliss, Davis, and Rodgers were all recognized as having, in some form, qualifications arising from eminence in science or from a familiarity with scientific affairs; and it was this consideration which prompted their selection, and not merely the fact that they were naval officers. We might therefore claim that Secretary Chandler himself had deviated from precedent in appointing superintendents on the sole ground of naval rank. Indeed, we believe that Secretary Chandler was the first who ever gave any real hearing to what the astronomers of the country had to say on the subject. On all previous occasions, vacancies in the superintendency had been filled so quickly, that they never had had time to give an organized expression to their views at the critical moment, even supposing they had been disposed to find fault with the selection, which certainly was not always the case. A plaintiff whose suit had been postponed from time to time for forty years might well feel dissatisfied, if, when finally heard, the decision of the judge should be, that the defendant had remained so long in possession, that he must now keep possession, no matter what the merits of the case. It should not be forgotten that the theory that the observatory needs nothing but an administrative officer, whose sole duty it shall be to take charge of the building and grounds, preserve order, and conduct the correspondence, leaving the scientific work to the professors and lieutenants, was never heard of, except when no other argument was available, and is now not likely to be supported even by the line-officers themselves.

The tersest form in which the case is put by these officers is this: "The system has been tried for forty years, and has worked well; let us leave well-enough alone." But has there been any system? Certainly not, unless a total absence of system can be called a system. And in what way has it worked well? This depends on the standard by which we measure it. We may admit that in the eyes of the conservative public every thing which does not lead to utter destruction, or against which nothing is heard, is looked upon as working well. We once heard a popular superintendent highly praised, because, having the professors completely in his power, he did not embarrass them by vexatious interference, but had the forbearance to let them go on with their work without hindrance. Last spring, when the question had given rise to a lively discussion among scientific men generally, one of the most eminent foreign astronomers who has landed on our shores paid us a visit. He was, of course, restrained from any public expression of opinion on the subject, but could respond frankly to all inquiries. When asked for his views, he said in substance that individual astronomers had done important works, and made great discoveries at the naval observatory. But, he added, when we look further, and inquire what the observatory itself has done by organized work, we find a great want. There has been no unity, no continuous plan of work, and few of the results which might have been gained by organized action. He might have stated the case yet more strongly. The published observations of the thirty-five years are of every possible character, from the refined discussions of the accomplished astronomer to the vain efforts of the tyro working in the dark, and the confused records of careless men who did not know what to do, and cared for nothing except to draw their pay, — all put in without discrimination. The astronomer of the future who shall try to make use of the results will be surprised by the kaleidoscopic character of the impression made upon him as he turns from volume to volume. Here a new series of observations suddenly begins. He will follow them through a few months or a few years, and find them as suddenly broken off, right in the middle, perhaps, and just when they might have led to some useful result. New systems of observation and new methods of calculation will be found coming in from time to time without any apparent reason. Every effort he may make to discover a method in the madness will be vain. To find an explanation, he will have to inquire into the *personnel* of the observers. By careful research he will then find, as a curious coincidence, that, when these changes occurred, some observer had died or left the observatory, or there had been a change of observers at the instruments. And this is the so-called 'system,' to the perpetuation of which the country is asked to dedicate the new observatory, to be built at a cost of half a million dollars.

The attitude of the naval officers, under these circumstances, is of much interest, because it depends very largely on them to determine whether this confusion shall continue indefinitely, or whether some permanent plan of work shall be adopted. If the indications of their views and intentions which have reached us since the discussion began are correctly interpreted, they have resolved on a course which cannot but prove equally disastrous to naval and national science. Common report credits them with a determination to 'hold the fort' at all hazards, and to vigorously contest every effort that may be made to place the observatory under scientific control. There are even indications that the dismissal of some or all the civilian astronomers is desired, in order that none but naval officers may be left to do the work.

Such a prospect naturally leads us to consider the relations of the navy to science. Scientific organizations have shown on every occasion their high appreciation of the efforts of naval officers to secure a scientific training for themselves, and to advance knowledge by their own efforts. Every thing they have done has met with generous recognition from their civilian co-laborers, and they are received upon terms of perfect equality in every enterprise in which they have taken part. There is no scientific position which would be denied them on the ground that they were naval officers, and therefore to be regarded as inferiors. To maintain this cordial relationship, nothing more is necessary than that the officers should admit the equality, and make no claims except those which are founded upon merit. When they begin to claim precedence and control on the ground of naval rank, they assume a position in which they will meet with the combined opposition of their scientific co-laborers, and render all co-operation impossible.

The application of these considerations to the present case is very simple. Naval officers will not find, in scientific quarters, the slightest opposition to their doing any work at the observatory which will either advance science, or lead to their own professional improvement. It is, indeed, a mooted question, whether the work can really be well performed by any but a permanent staff of trained assistants, and it must be admitted that the observations made by naval officers in the early years of the establishment were not a success. But the officers may justly claim that what they did then is no test of what they can do now, when a better training has been secured, and a scientific spirit has been infused into the service. There is no such question raised on the scientific side as, Shall you or shall we do the work? Shall you or shall we superintend it? What is, then, the ground taken by the general scientific sentiment of the country? Of course, in answering a question of this kind, differences of individual views will be found, and no answer can be given which all will accept without modification. But we are persuaded that there will be no difficulty in reaching some conclusions which will correctly represent the average common sense of the great mass of those who are interested in the subject. We state them as follows: —

Give the naval officers every possible chance, and let them do every thing which they shall prove themselves able to do. Let the superintendent be the man, who, in the opinion of the astronomers of the country, is best fitted for the place, whether naval officer or civilian.

But let the questions, what shall the observatory do, how shall it be done, and is what is done good, be decided exclusively by the highest scientific authority, acting, not privately, and upon the motion of the superintendent, but officially, with the weight and responsibility of legal appointment. Let this authority represent, not merely the navy department or naval science, but the science of the whole country, and let the superintendent, whoever he may be, be responsible for executing its decisions. The shape it would naturally take would be that of a board of control, composed of the leading astronomers of the country.

We state these points, not as forming a definite plan, or even laying a basis for such a plan, but only as indicating the spirit in which we hold that the case should be considered by the two parties. What we ask is as much for the intellectual benefit of the navy itself as for the good of science, and we earnestly hope that naval officers will meet our views in the spirit in which they are put forth.

THE NATIONAL RAILWAY EXPOSITION.[1] — V.

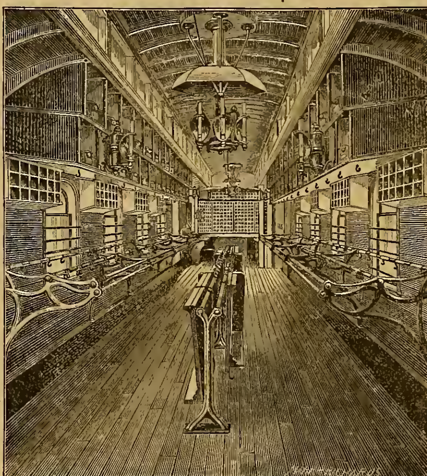
THE postal-car shown by the Harrison postal-bag rack company of Fond du Lac, Wis., appears to be conveniently arranged, and possesses many ingenious but simple devices for facilitating the conveyance and sorting of letters and newspapers. The sorting-tables are not fixed, but are hinged by means of hooks on movable stanchions; and each table, measuring about forty-two inches by eighteen inches, can be detached and stowed away, so that any num-

[1] Concluded from No. 26.

ber can be utilized, and the remaining space left clear. The mail matter can also be sorted directly into bags, which are hung open mouthed, at their four corners, on cast-iron brackets, and these can also be folded out of the way when not required. The letter-boxes are provided with clips, into which labels can be inserted, showing the destination of the letters sorted into each particular box.

The Pullman palace-car company had a very large exhibit of sleeping and dining cars, including an emigrant sleeping-car, which will doubtless prove a great luxury to settlers journeying to the far west. The berths are arranged as in an ordinary sleeping-car, but consist merely of slats of ash, the bedding and mattress (if any) being provided by the emigrants themselves.

A new style of sleeping-car, the second of its kind ever built, was shown by the Paige sleeping-car company. The top berth does not fold up against the roof of the car, but is a species of rectangular hammock, hung at the ends from partitions between the sections. These partitions, in the day-time, are lowered into a space between the backs of the seats. The lower berth is not made on the seat, but on a similar canvas hammock.

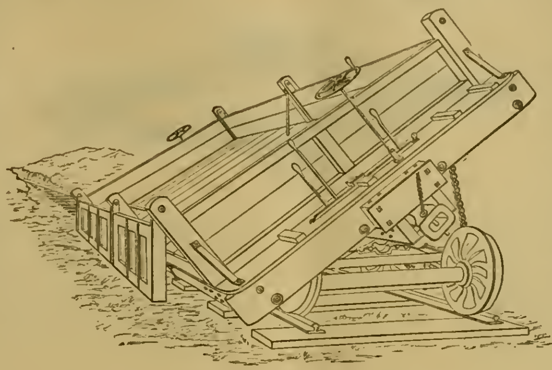


POSTAL-CAR RACKS.

A screw lever dump-car on Van Wormer's patent is shown by the U. S. car company of Boston, Mass. The centre support on the trucks is a species of ball-and-socket joint, combined with segments of two-toothed wheels, — one segment being bolted to the top of the truck-bolster, and the other to the under side of the bottom framing of the car; the effect being, that, when the car is tipped, it rolls on the trucks, the fulcrum on which it rolls being brought directly under the centre of gravity of the car and its load, which, of course, shifts as the car is tipped. When the load is dumped, the position of the centre of gravity tends to restore the car to its normal position: the arrangement, therefore, assists the man in charge both in dumping, and in restoring the car to its running position. The rockers, with the central ball and socket and segmental cogs or teeth on either side, are shown in our illustration. When the car is to be dumped, the side-supports are withdrawn by means of levers on the end-platforms, and the car is tipped to either side by means of a worm actuated by a hand-wheel. As the bottom of the car is solid, it can be made stronger than a hopper-bottom car, and can be used for freight, which requires a flat floor, and cannot be loaded in a hopper-bottom car. It is stated that one man can unload forty thousand pounds of coal, sand, ballast, or iron ore, in two minutes by means of a dump-car, two hours being required to shovel out the same load.

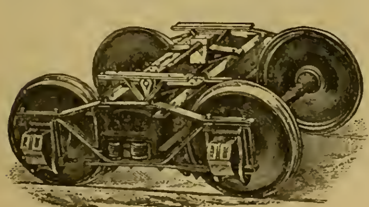
The Suspension car-truck manufacturing company of New York exhibited several trucks made on their principle, suited for freight, passenger, and horse cars, and showed a model truck which traversed an abnormally rough piece of track with a very smooth and easy motion. The car is connected to the truck by means of links, which swing in a vertical plane parallel with the track, instead of at right angles to it, as in the swing-beam truck; while the axle-boxes are connected to the trucks by means of links, which permit independent side-motion to each axle. The normal position of all the links is vertical, and they become inclined as the truck enters a curve, and therefore tend to restore it to a central position when the truck enters a piece of straight track again.

The principle of the truck is entirely novel, and, though really simple, is best understood by a few minutes' examination of a model. Two brackets, resembling the letter A reversed, are attached to the under side of the car. At the apex (now the lowest point) of the A are attached vertical links, the other end of which are attached to the truck at *B*, *B*, in our diagram. As the truck enters a curve, one of these links becomes inclined forward, and the other backward. As the wheel *C* strikes against the outer rail of the curve, it is thrown towards the inside of the curve (assuming the position shown by the dotted lines in the figure), and the suspension-links force that side of the truck forward, while the wheel *D* comes backwards; and therefore the action of the links tends to make the axles radiate to the curve. No centre-pin is used; and therefore, when a car is heavily bumped in switching, it merely swings backward on the links until they become sufficiently inclined to drag the truck after the car. It should be noted that the pin *E*, which connects the links to the truck, is a loose fit in the links, and therefore allows of the necessary radial motion. The top ends of the links, being attached to the truck, are always approximately a fixed distance above the rails; and therefore, when they are inclined, the car itself is lifted, and the weight of the car, hence, tends constantly to keep the links vertical, and maintain the truck in its normal position, with the axles at right angles to the axis of the car, so that it runs steadily on a straight line. The truck appears to be very highly thought of by the master car-builders, whose convention was held in Chicago during the exposition: and it is possible that it may come into extended use, the experience of the Boston and Albany, Connecticut River, and other roads which have used it, being strongly in its favor.



DUMP-CAR.

The Cliff and Righter company of Oswego, N.Y., exhibited a car-spring which gives an equal amount of elasticity, with a less amount of metal than the ordinary elliptic spring. Each half-spring consists of a solid steel bar of oval section, properly tapered towards the ends. Springs as usually made, of four, five, or more plates, resemble a set of somewhat elastic girders, the depth of each of which is the thickness of the plate; and the strength of a spring is the sum of the strength of each individual plate or girder, modified by the fric-



SUSPENSION CAR-TRUCK.

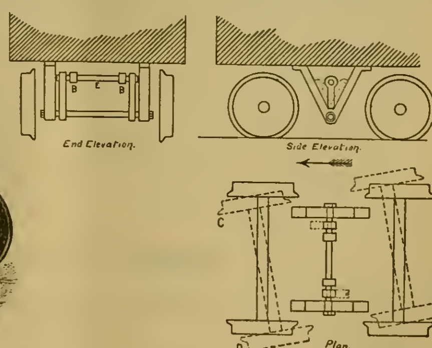
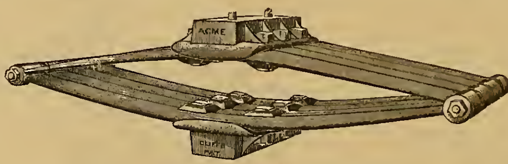


DIAGRAM SHOWING ACTION OF SUSPENSION CAR-TRUCK.

tion between the plates. It is obvious, that, were the plates to firmly adhere together, the strength of the spring would either be very largely increased, or the same strength might be attained by the use of a less number of plates; and the latter course has been carried to its limit by the patentee of the Cliff spring. A spring made of one plate must be of good steel, as, when loaded, the difference in the alteration of the lengths of its upper and lower surfaces is considerable, demanding a highly elastic steel. In the spring we illustrate, four springs are arranged side by side, — a plan which unites the advantages of a plate spring and a solid spring. Should one spring break, the other three will probably carry the load, while four springs side by side weigh no more than a spring of the same total strength, composed of a single bar of the same thickness, but of four times the width. A set of these springs for a passenger-car weighs nine hundred and twenty-eight pounds, while a set of the Pennsylvania railroad standard springs for the same purpose weighs sixteen hundred and thirty-two pounds, a difference of seven hundred and four pounds in favor of the solid spring. These springs have been lately introduced, and are being tried on the Boston and Albany and other railways. The difficulties of tempering and making a spring of one solid bar are considerable; but it is to be hoped they may be surmounted, as the weight of cars is a serious evil, "which has increased, is increasing, and ought to be diminished."



ELLIPTIC CAR-SPRING.

Mr. S. P. Tallman of New York exhibits a safety-drawbar for cars. Two pieces of timber are bolted between the middle sills of a car, and others are bolted to the under side of these timbers and the middle sills, forming a solid mass of timber, which receives both the buffing and drawing strains, the drawbar running through the timber, and being provided with springs at both ends. The spring nearest the draw-head takes the buffing-strain, and the spring at the end of the drawbar serves as a draw-spring. The disposition of the timbers enables them to be secured by more than the usual number of bolts, and the arrangement appears to be strong and simple, and not so liable to failure as the ordinary draught timber.

DRAWBAR.

Numerous refrigerator-cars were exhibited; and doubtless improvements will be much facilitated by the opportunities thus given to secure information, though it is to be regretted that the management of the exposition did not take steps to secure an efficient competitive trial of the cars under practical conditions. Beer, fruit, vegetables, etc., might have been placed in the cars, and locked up for a few days, when a careful examination of the contents would have given some indication of the relative merits of the cars.

The use of continuous brakes on passenger-trains has been found to be so advantageous, that their adoption on freight-trains is merely a question of time. Several forms of continuous brakes, applicable to freight-trains, were exhibited; the Westinghouse brake company showing a cheaper form of their well-known automatic brake, the reservoir being made of cast iron, and bolted to the cylinder. The triple valve, however, and other parts, differ little, except in size, from the brake used on passenger equipment. A cheaper form of brake, which requires no special pump or other fittings on the engine, or even a continuous brake connection through the train, is operated by the action of the ordinary hand-brake on the tender. The consequent compression of the draw-heads in the train is made by the peculiar mechanism of this brake-gear to apply the brake-shoes to the wheels of the cars.

This form of brake is peculiarly applicable to freight-service, as it allows of cars not fitted with the brake being run in the train without interfering with the use of the brake on the cars equipped. This class of brake can hardly be termed 'automatic' in the fullest sense of the term, insomuch as it does not work, should the train part in two. On the other hand, failure on any one car cannot impair the efficiency of the brake on the rest of the train.

The American brake company of St. Louis, Mo., exhibited full-sized working-models of a brake of this class.

Between the floor-sills, and at the inner end of the drawbar, is hung a bell-crank lever, *B*, which carries in one of its jawed ends the push-bar *A*, and, in the other, double-pull rods carrying a spiral spring transmitting the strain to bell-crank levers, *D*,*D*, suspended from the sills by hangers, *C*,*C*. The bell-cranks *D*,*D*, are connected to the brake-beams; and consequently compression on the draw-head acting on the lever *A* causes the brake-shoes to be pressed on the wheels, the amount of pressure being regulated by its transmission through the spiral spring. But, since a brake simply made as above described would not admit of a train being backed, a device is attached which removes the objection, and, further, only allows the brake to be applied when the car is moving at a speed above six miles per hour.

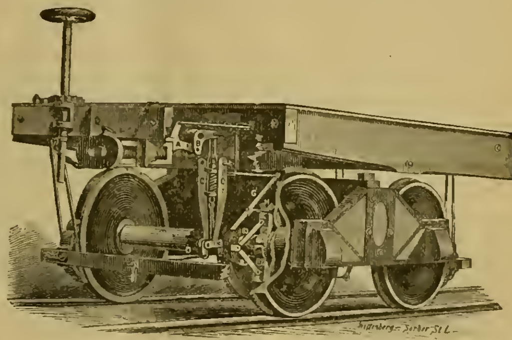
The push-bar *A* can only come in possible contact with the draw-head by the centrifugal force of governor-balls attached to the axle. These balls, *E*,*E*, are attached by means of links to a movable disk, *F*, encircling the axle. One end of a lever, *G*, bears against the disk, and the other end is connected by means of rods, etc., to the push-piece *A*. When the car is running at speed, the governor-balls draw the disk towards them, leaving the lever *G* free to follow it, and permitting the push-bar *A* to drop behind the draw-bar, when the brake is ready for action, going on directly the draw-gear is put in compression. When the speed falls below six miles an hour, the centrifugal force of the governor-weights becomes so feeble, that a spring (not shown in the illustration) restores the disk to its former position, lifting the push-piece *A* clear of the draw-head.

The brakes can be released at any time by the engineer putting on steam, and giving a pull to his train; and the train can be backed from a state of rest without the brakes going on, the push-piece *A* lying on the draw-head, but being unable to fall behind it.

The engineer can apply the brake, when pushing the train, by momentarily applying the brake on the engine or tender, thereby putting the draw-gear in tension, and letting the lever *A* fall behind the draw-head. When steam is again put on, the consequent compression applies the brake.

This brake has been in use for some time on the St. Louis and San Francisco and many other railroads, and appears to give very satisfactory results; the wear being very small, while the first cost is low enough to allow of its extensive application to freight-cars.

The brake exhibited by the Tallman automatic car-brake company of New York also acts by the compression of the draw-heads, which force together two friction-wheels, one of which is keyed on the axle, and the other is geared to a drum winding up the brake-chain. A ratchet-wheel, which can be shifted by hand, prevents the brake from acting when the train is backed.



AUTOMATIC BRAKE.

The Waldumer electric brake company of Chicago exhibited a working-model of a very promising form of continuous brake, which is just emerging from the experimental stage. The weak point of all continuous brakes has been the conveyance of the operating force — compressed air, vacuum, hydraulic power, etc. — along the length of a train, the pipes and couplings being generally expensive, and formed partly of perishable substances, while chains are unsatisfactory from every point of view. Many brakes that work well and promptly on a short train become slow and irregular in their action, when applied to a train of thirty or more vehicles. The instantaneous action of electricity, and the simplicity of the means used for its transmission, make it probable that an electric brake would be especially suited for long freight-trains. The brake is automatic, the fracture of wire or draw-gear ringing bells on engine and caboose, and warning both engineer and conductor that the train has parted, each being then at liberty to apply the brake or not, on his portion of the train, as he may deem best. Owing to the system of circuiting, the brake may be out of order on one car without affecting the rest of the train.

The street-car starter and brake exhibited by Charles T. Brown & Co., Chicago, is an ingenious device for storing the momentum which is destroyed by the usual form of brake, and utilizing it for restarting the car. The motion is not checked by friction, but by the axle, which, through suitable gearing, winds up a spiral spring, the power of which is available to again put the car in motion. The mechanical details appear well worked out, and the car can be run in either direction, and stopped or started on either up or down grades. The heavy pull necessary to start a car is very severe on horses, and this invention would appear to be useful in saving much wear and tear of horse-flesh.

D. H. O'Neale Neale.

A HEARING OF BIRDS' EARS.[1]—I.

The 'musical class' of vertebrates enjoy the sense of audition to a high degree. Otherwise birds would cease to sing. They are the only animals besides man whose emotions are habitually aroused, stimulated, and to some extent controlled, by the appreciation of harmonic vibrations of the atmosphere. Most birds express their sexual passions in song, sometimes of the most ravishing quality to human ears, as that of the nightingale, skylark, or blue-bird; and it cannot be supposed that they do not themselves experience the effect of music in an eminent degree of pleasurable mental perturbations. The capability of musical expression resides chiefly in the male sex; the receptive capacity of musical affections appears to be better developed in the female. There is, however, no anatomical difference in their ears. Quickness of ear is extraordinary in some birds, as those of the genus Mimus (mocking-birds), which correctly render any notes they may chance to hear, with greater readiness and accuracy than is usually within human compass; and it may be reasonably doubted whether any other animals than some of the world's greatest musical composers have a higher experience of acoustic possibilities than many birds possess.

Birds' ears have nevertheless a simple anatomical construction, in comparison with those of mammals. The auditory organ is decidedly of the reptilian type; and the arrangement of the parts is, on the whole, quite like that of reptiles. Thus, the cochlea, which in mammals makes from one and a half to five whorls (two and a half in man), is simply a strap-like prolongation from the vestibule, lacking modiolus, lamina spiralis, etc.; the stapes is the only perfected ossiculum auditûs; the incus is scarcely recognizable as such, and inseparable from the stapes; the malleus is immense, but outside the ear, furnishing the articulation of the lower jaw, of the zygomatic arch, and of the pterygo-palatal bar; the tympanic bone is represented at most by a few specks of ossification. There is ordinarily no external ear; the whole tympanic cavity is exposed on removal of the membrane, which lies very superficial; the eustachian tubes unite before opening into the pharynx; the periotic bone, constituting the otocrane or skull of the ear, is less compact and precise than the 'petrous portion' of the mammalian temporal bone, its three bony elements being more distinct; no mastoid portion is recognizable as such, but pneumatic cells of diploë are numberless, and there is direct passage of air from the ear into the hollow of the lower jaw; one of the semicircular canals invades the occipital bone. Other peculiarities will appear as we proceed with our description, in which comparisons will be chiefly made with the human ear.

Most birds have no external ear, in the sense of a fleshy conch or auricle. In bald-headed birds, the meatus externus appears as a roundish orifice at the lower back corner of the head, just above and behind the articulation of the lower jaw. In nearly all birds, the opening is hidden by an overlying packet of feathers, collectively termed the *auriculars* or ear-coverts, on simply raising and reflecting which the meatus is exposed. The auriculars are peculiarly modified feathers, having loosened barbs, doubtless to lessen interference with the passage of sound. In a few birds the border of the meatus develops a slight tegumentary fold, partially occluding the orifice. In various owls, as of the genera Strix, Aluco, Asio, Nyctala, but not even throughout this group of birds, an immense tegumentary *operculum*, or ear-cover, is developed, which flap shuts down upon the ear-opening like the lid

[1] Complementary to the article entitled 'The nature of the human temporal bone,' *Journal of otology*, January, 1882. Some portions of that article may perhaps be made clearer by the present one, especially those relating to the parts of a temporal bone as elements of mandibular and hyoidean arches. Figs. 1-4 are borrowed from Prof. W. K. Parker's admirable essay on the development of the fowl's skull, in Encycl. Brit., 9th ed., art. Birds; figs. 5-9 are from Prof. I. Ibsen's beautiful memoir, as cited in the text.

of a box. It hinges upon the anterior border of the meatus, and shuts backward. In some cases the operculum is about as long as the whole skull is deep, and half as wide as long — say, two inches long by an inch wide. On raising such an ear-flap and turning it forward, enormous external bony ear-parts, covered with integument, are displayed. Such expanse of the outer ear results from extension of occipital and squamosal bones into a thin shell bounding the meatus externus above, behind, and below. In the best-marked cases of the kind, especially in Nyctala, the parts are exaggerated unsymmetrically on right and left sides, and the whole cranium is distorted. This inflation of the cranium does not affect the inner ear-parts, or the essential organ of hearing. It should be added, in passing, that the so-called 'ears' of various owls, as the 'long-eared' owl, Asio otus, and 'short-eared' owl, Asio accipitrinus, are simply tufts of feathers on top of the head, over the eyes; these topknots having nothing whatever to do with the ears. Their proper name is plumicorns.

Aside from any such irregularities, the outer ear, or meatus auditorius externus, is a considerable, shallow, roundish depression, in the situation shown in fig. 1, where the reference line 5 crosses it, and where the cross-like object (stapes) marked *st* is seen lying in it. Its ordinary boundaries are, the enormous *malleus* or quadrate bone, *q*, in front; the expanded rim of the *squamosal*, *sq*, above; the *tympanic wing of the exoccipital* (a production of the lateral condylar plate of the occipital, *teo* in fig. 2), behind and below. A bone unknown in human anatomy, the *basi-temporal*, which floors the skull from ear to ear, underlying the basi-occipital and basi-sphenoid, also usually contributes to the inferior boundary of the meatus. On removing the quadrate (malleus), the general tympanic depression is seen to be more or less directly continuous with the alisphenoid, and so to conduct into the orbital cavity; the boundary of the meatus being best marked behind and below by the expansive thin-edged shell of the tympanic wing of the exoccipital. To the brim indicated is attached the membrana tympani; the ear-drum being thus from the configuration of the parts quite superficial, instead of being at the bottom of a long cylindrical tube, as in man. There is, in fact, in birds, no 'meatus auditorius externus,' in the sense of a special bony tube; some slight specks of ossification, when any, about the tympanic membrane itself, being all there is of a *tympanic bone* ('external auditory process' of human anatomy).

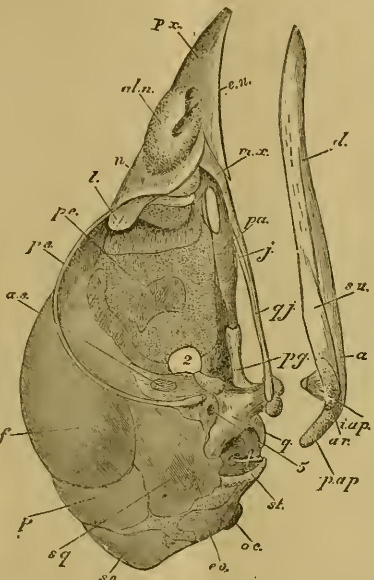


FIG. 1. — Ripe chick's skull in profile, × 3 diameters. (After Parker.) *px*, premaxillary; *aln*, ali-nasal cartilage; *en*, septo-nasal; *n*, nasal bone; *l*, lachrymal; *pe*, perpendicular plate of ethmoid; *ps*, presphenoidal region; *as*, alisphenoid; *f*, frontal; *p*, parietal; *sq*, squamosal; *so*, superoccipital; *eo*, exoccipital; *oc*, occipital condyle; *st*, the cross-like object, the stapes, whose foot fits *fenestra ovalis*; *q*, quadrate; *pg*, pterygoid; *qj*, quadrato-jugal; *j*, jugal; *pa*, palatine; *mx*, maxillary; *2*, *optic foramen*; *5*, *foramen ovale*, for inferior divisions of the fifth nerve. In the mandible: — *d*, dentary; *su*, surangular; *a*, angular; *ar*, articular; *iap*, internal angular process; *pap*, posterior angular process.

Such shallowness, openness, and superficiality of the parts, brings the cavity of the tympanum or middle ear into full view on removal of the tympanic membrane. On looking into this cavity, as may readily be done in clean, dry skulls of any size, many objects of interest may be studied without further dissection. We observe in the first place a large (inconstant) number of *pneumatic foramina* leading in various directions, conveying air from the middle ear-passage into the air-cells of bones of the skull, including the lower jaw. The most special of these is a neat gristly or bony air-tube into the lower mandible. The mouth of the eustachian tube is a large orifice at the lower anterior part of the cavity. This tube, as usual, continues an air-passage to the pharynx, opening at the back of the hard palate by a median orifice in common with its fellow. In sizable skulls, as of a raven, hawk, or eagle, a bristle or even a wooden toothpick readily traverses the conduit which runs between the basisphenoid and the underlying basi-temporal. This whole passageway, from outer ear to tympanic cavity, and thence through eustachian tube to pharynx, represents the persistently patulous part of the first post-oral visceral cleft of the embryo, only occluded by the membrana tympani. Near the eustachian orifice are observed two definite openings. The anterior and superior of these is the fenestra ovalis, fitted, as usual, with the foot of the stapes, as seen in fig. 1, closed by membrane, which further occludes this opening into the *vestibular* cavity. The other is the fenestra rotunda, similarly leading into the *cochlear* cavity. The two are generally close together, separated merely by a bony bridge or bar. The former lies always in the obliterated suture between the proötic and opisthotic elements of the petrosal bone, the latter wholly in the opisthotic; both are thus as in man. Close examination at a point somewhere about the fenestra ovalis will discover a minute foramen, corresponding to the human 'stylo-mastoid foramen' inasmuch as it represents the orifice of exit of the seventh cranial nerve ('portio dura') from the petrosal bone, here in the cavity of the middle ear, there being none such upon the outside of the skull. Thus, in the dry skull of a bird, the hard parts of the tympanic cavity, including the eustachian tube, can readily be inspected from the outside; even the limits of the proötic and opisthotic bones can be determined by the site of the fenestra ovalis, and the ossicula auditus be seen *in situ*. To see these things in the human or any ordinary mammalian ear, requires special preparations, as they lie in a tympanum which is itself at the bottom of a contracted tube. Details of mere size and shape aside, the above general description of the passageways will apply pretty well to any bird, and should suffice for recognition of the parts; though the number and variety of the irregular pneumatic openings (comparable to those of the human mastoid cells) may be puzzling at first sight.

(*To be continued.*)

ON THE KINETIC THEORY OF THE SPECIFIC HEAT OF SOLIDS.

IN a paper entitled 'Kinetic considerations as to the nature of the atomic motions which probably originate radiations,'[1] the writer has given reasons in support of the hypothesis that different chemical atoms are all composed of the same kind of ultimate atoms, which are in every respect equal and similar. Reasons were also given, tending to show that the vibrations of these ultimate atoms originate luminiferous and thermal radiations. And further, supposing radiations to originate in the vibrations of equal and similar ultimate atoms which are set in vibration by the collision of moving molecules, an attempt was made to prove that two unlike masses of gas which are in thermal equilibrium by radiation will also be so when mixed; i.e., when the equilibrium depends upon the collisions of the molecules rather than upon radiation.

The object of the present paper is to consider the probable physical state of solid bodies, especially as to the amount of energy distributed among the different degrees of freedom possible in such bodies, and to show that the same hypothesis of equal ultimate atoms would cause solids which are in thermal equilibrium by radiation to be also in thermal equilibrium when brought into contact, i.e., when the equilibrium depends upon the collisions of the molecules.

Let us notice, in the first place, what is apparently the mechanical significance of Dulong and Petit's law, which may be stated thus: the amount of heat which must be imparted to a chemical atom of a simple solid body to increase its temperature one degree is approximately the same for all the elements. Neumann has further shown, that, for compound solids, those of similar chemical composition require approximately the same amount of heat per chemical atom, but the amount is less than for simple solids. There are, however, a very few unexplained exceptions to these laws, which are due possibly to uncertainty as to atomic weights.

The mechanical explanation of these experimental laws seems to be contained in the statement, that, in simple solids, cohesion and chemism are one and indistinguishable; or, to express it otherwise, we may say that the molecules of simple solids are monatomic, the cohesion being, of course, much greater in some solids than in others.

That this is a correct conception of the relations of the atoms of a simple solid, is made probable by various facts, among which this may be mentioned, — mercury and cadmium, which are known to be monatomic as gases, as solids fulfil Dulong and Petit's law, and are therefore in the same physico-chemical state

[1] SCIENCE, ii. 76.

as other simple solids. Another fact is that already mentioned, viz., the specific heat of compound solids per atom is less than that of simple solids; and to this it may be added, that the specific heat of simple solids is less when the volume is made smaller by hammering, compression, or cooling, which facts will be considered more at length later.

It is shown in the kinetic theory of gases, that, when molecules of unlike gases are mixed, the mean progressive energy of each molecule is the same, whatever its weight.

Now, when a gas is in contact with a solid, will the collisions of the gaseous molecules with those of the solid cause the latter to have the same mean progressive energy of vibration as those of the gas? That will depend largely upon the duration of the collision. If the time occupied by a collision is so brief that only a small portion of a vibration of the solid molecule is described during the collision, then the laws of impulsive forces may be applied, according to which the effect of the finite forces acting during the interval may be neglected.

In case the collision is brief, the distribution of the mean kinetic energy between the molecules of the gas and solid will be very nearly the same as between different gases, and the mean kinetic energy of a simple solid molecule will differ little from that of a gas at the same temperature.

In cases, however, in which the modulus of elasticity of the solids considered is so great as to make the period of vibration of the molecules also brief, their mean kinetic energy would be materially smaller than in the previous case; and, if a solid could be found whose molecules were immovably fixed, no vibratory energy whatever could be imparted to its molecules.

Now, Dulong and Petit's law seems to show that all simple solids, even those having the highest modulus of elasticity, have an elasticity so small, compared with that brought into action between molecules at the instant of free collision, that the distribution of kinetic energy is approximately the same as if the body were gaseous and monatomic. But since the laws of perfect elasticity require that the mean potential energy shall be equal to the kinetic, it follows that the specific heat of a simple solid should be approximately twice that of a monatomic gas at the same temperature and of the same atomic weight.

The actual specific heats of mercury and cadmium gas would be of great interest in this connection, were they known, even though they could only be determined at temperatures far removed from those of their solids.

The foregoing statement has been based upon the assumption that any degree of freedom which suffers partial constraint, as do the degrees of freedom of translation of a gaseous molecule when it becomes solid, will have for that reason less kinetic energy imparted to it during molecular collision. This subject has been treated somewhat at length in previous papers upon the kinetic theory: but in this connection it may be useful to make a quotation from Thomson and Tait: "If a set of material points are struck independently by impulses, each given in amount, more kinetic energy is generated if the points are perfectly free to move, each independently of all the others, than if they are connected in any way."[1]

This mechanical theorem not only has special application to the partial constraints introduced into the freedom of motion of molecules when they change from a gaseous to a solid state, but it applies, also, to the additional constraints introduced into the degrees of freedom of solid atoms when those atoms become more closely bound together by chemism into groups, i.e., into molecules. Evidently, the bonds of union between the atoms of a compound solid molecule are such that these degrees of freedom are considerably more constrained than those which unite the atoms of different molecules; so that, in compound solids, the forces of cohesion and chemism are different, and quite distinguishable the one from the other.

Now, what, according to the mechanical theorem above quoted, is the effect of introducing the additional constraints required in order to group a simple solid, or mixture of simple solids, into molecules, and thus make it a compound solid? The effect will be to diminish the mean kinetic energy of the system as derived from the impacts of the molecules of any gas surrounding it. This is, in fact, what occurs, as appears from the experimental truth previously mentioned, — that the specific heat per atom of compound solids is less than that for simple solids. How much the specific heat per atom is diminished should depend upon the intensity of the chemical attraction, which certainly must be much greater than the cohesion between atoms of simple solids, to cause such marked deviations of specific heat per atom as compound solids exhibit. This result, when combined with that arrived at in connection with the discussion of Berthelot's law, in my paper upon 'An extension of the theorem of the virial,' etc., to the effect that the heat evolved in chemical decomposition is greater

[1] *Nat. phil.*, art. 315.

the greater the attractive force, enables us to enunciate the following law, the truth of which I am at present unable to verify for want of sufficient experimental data: those solids, other things being equal, which evolve the greater amounts of heat of chemical decomposition in changing from simple mixtures to compound solids, are those which have less specific heat per atom. The phrase, 'other things being equal,' in the above statement, refers to the fact that similar compounds which are chemically similar are in strictness comparable. Many other circumstances, moreover, besides want of chemical similarity, may, in special cases, mask the experimental results; yet the truth of the law should be clearly recognizable in any general comparison of specific heats with the heat of formation of compound solids.

Similar principles evidently apply to the cases in which simple solids are permanently decreased in volume by hammering or compression; for then greater cohesive forces are brought into action, and the specific heat is diminished. It remains to be shown, in conclusion, that thermal equilibrium, which has been established by collisions of gaseous and solid molecules, will continue to exist when its continuance depends upon radiations between equal and similar ultimate atoms which are set in vibration by molecular collisions; or, to state it differently, it remains to be shown that the ultimate atoms of a gas and a solid in contact, each have the same mean vibratory energy with respect to each of their degrees of freedom with respect to each other. This appears to be a direct consequence of the laws of constrained motion which have been considered in this and previous papers. It is only necessary that the impacts of a pair of solid molecules with each other should be such as to mutually impart and receive the same mean amounts of energy as would those of a gaseous and a solid molecule at the same temperature, to cause it to be a matter of indifference whether a given solid molecule is struck by another solid molecule or by a gaseous molecule; and, when so struck, each ultimate atom will receive its proper proportion of energy, whether it form part of a solid or of a gaseous molecule.

It is my intention to return to this subject hereafter, and to treat the vibrations of ultimate atoms more at length, in the hope of being able to show, more precisely than has been done so far, how the characteristic differences in the spectra of solids and gases arise.

H. T. EDDY, Ph.D.

CLIMATE IN THE CURE OF CONSUMPTION.—I.

THE prevalence of phthisis pulmonalis is such a well-attested fact, that to adduce statistics to prove it would seem to be labor thrown away. Since the eradication of small-pox in consequence of the introduction of vaccination, phthisis heads the list as the prime cause of the large mortality. The insurance companies recognize the fact, and the statistics of the New-York mutual life-insurance company show, that between the ages of twenty and thirty years the mortality from phthisis is thirty-three per cent of the whole mortality. The U. S. census for 1870 shows that in the state of Maine the mortality from consumption was fifty per cent for the same ages.

Equally well known is the belief in climate as a cure for the disease. There are certain well-recognized climatic conditions known to be favorable to the prophylaxis and cure of the disease. This knowledge is largely empirical, based upon trial and observation; but there is, underlying it, a substratum of conviction, that is justified, on the one hand, by careful clinical observations, and, on the other, by facts ascertained by carefully conducted experiments.

The writer proposes, in the thoughts to be presented, to make these various elements his tests in searching out a desirable climate in the United States for the cure of phthisis. He offers, as his data for forming an opinion, carefully compiled tables, furnished by the Signal-service bureau, U.S.A.; and he wishes to emphasize the fact, at the outset of his remarks, that a climate may become desirable quite as much by comparison as on account of its intrinsic properties; that even though it may not possess in itself all desirable qualities, yet it may contain so many as to be, by comparison with others, the climate par excellence. With this thought in view, the writer has prepared tables embracing all the chief resorts in this country for phthisical invalids, — tables embracing a range of the whole country, from Jacksonville to St. Paul, and from Boston to Los Angeles.

He has given the data for Augusta, Ga., as the best substitute for Aiken, S.C., at which place there is no signal-station; and in doing so he thinks that he is presenting data which will fairly represent the climatic conditions of Aiken.

He wishes to gratefully acknowledge his indebtedness to the chief signal-officer, U.S.A., to the observers at each of the stations included in the tables, and especially to Sergeant F. M. Neal of the Denver station, for their kindness in furnishing him with the data from which the tables are compiled.

TABLE I.

Station. The figures giving the elevation represent the height of the barometer above sea-level.	I. Elevation.	II. Mean 10 yrs. Barometer.	III. Mean 4 yrs. Relative humidity.	IV. Mean 4 yrs. Absolute humidity.	V. Mean 10 yrs. Precipitation	VI. Mean 10 yrs. Temperature.	VII. Mean 5 yrs. Prevailing wind.
Augusta, Ga.	183	30.140	69.2	4.56	48.98	64°.2	N.E.
Jacksonville, Fla.	43	30.030	69.0	5 38	55.94	69°.2	N.E.
Boston, Mass.	142	29.840	68.5	2.66	49.47	48°.5	W.
Newport, R.I.	34	29.950	74.3	3.07	50.20	50°.3	S.W.
New York, N.Y.	164	29.857	70.2	3.02	42.76	51°.3	N.W.
Philadelphia, Penn.	52	30.084	68.8	3.17	41.89	53°.2	S.W.
Chicago, Ill.	661	29.317	69.2	2.77	35.47	49°.3	S.W.
St. Paul, Minn.	811	29.133	67.3	2.23	29.59	43°.9	S.E.
Denver, Col.	5,294	24.778	45.8	1.81	14.77	49°.1	S.
Santa Fé, N. Mex.	7,046	23.263	41.4	1.61	14.17	48°.5	E.
Salt Lake, Utah	4,348	25.644	40.3	1.76	17.52	51°.8	N.W.
Los Angeles, Cal.	350	29.647	65.8	3.77	18.97	59°.8	W.

Elevation.

The effect of a rise in elevation is to diminish the atmospheric pressure. The method of measuring this effect is by means of the mercurial barometer. Disregarding the variations attributable to changes in temperature, humidity, and latitude, it can be broadly stated that the barometer will fall one inch for a rise of 857 feet above sea-level, two inches for a rise of 1,743 feet, three inches for a rise of 2,661 feet, etc.; or, for the purposes of a rough calculation, it may be said that the barometric depression is one inch for every thousand feet of elevation. This depression would indicate a diminution in atmospheric pressure of one-sixth in weight for an elevation of 5,000 feet: or, to state this fact in another way, the atmospheric pressure at sea-level being 15 lbs. to the square inch, at 5,000 feet it would be one-sixth less, or 12½ lbs. To illustrate: if the pressure on the entire surface of the body of a man of middle size be 35,560 lbs. at sea-level, at 5,000 feet it would be 29,635 lbs., a diminution of nearly three tons.

The question for us to consider is, what effect this diminution of pressure has upon the vital functions with reference to the cure of phthisis.

1. *Effect on circulation.* — The heart is a muscular organ, habituated to expend a certain amount of force, which may be roughly estimated as 75,000 kilogrammetres, or 542,475 foot-pounds, *per diem*. To accomplish this work at sea-level, the heart makes 72 beats a minute, or 103,680 beats a day. Allowing, now, an increase of two beats a minute for every thousand feet of elevation, at 5,000 feet there will be an increase of 10 beats a minute, or 14,400 beats a day, — an increase in work equal to about 74,744 foot-pounds in a day.

This in itself would prove that such an elevation is to be avoided in those cases where an enfeebled heart is struggling to overcome the disadvantages produced by organic lesions.

What effect does this increase of heart-work have upon the circulation? The rapidity of circulation is influenced by the force and rapidity of the heart's beat, and by the diminution of the peripheral resistance. At an elevation of 5,000 feet, each of these causes would be at work. To just what extent they work, in producing given results, it is impossible to say; but, allowing that the peripheral resistance and the force of the heart's beats remain the same at 5,000 feet as at sea-level, an increase in frequency of ten beats per minute would indicate, that, on account of this one factor, the blood would make 29,622 additional circulations through the system *per diem*. What effect would this have upon the disease in question?

It is a frequent remark that both waste and repair are more rapid at high altitudes than at sea-level. Experience amongst physicians shows that cases of fibrinous pneumonia are more acute and more rapid in their results at high altitudes than at sea-level. My own experience is, that resolution in such cases is more rapid, and that the chest 'clears up' sooner. May not this be explained on the ground of the increased rapidity of circulation? We know that the clearing-up is brought about by the expectoration of the morbid products of the exudation, and further, and chiefly, by their absorption into the circulation. If this be true of an acute trouble, is it not also applicable to a chronic asthenic one?

Further, the increase of rapidity in the circulation means that the same blood is brought more frequently to the lungs to be oxygenated, — an increase in the number of times, which we have seen to be equal to 29,622 additional times, *per diem.* This would indicate an increase in the activity of the metamorphosis of tissue, and therefore an increased vital force. This is clinically perceptible in the exhilaration that invalids experience on coming to higher altitudes, and by the increase in appetite dependent upon the demand for material to meet the additional metamorphosis.

There is the other side, however, which must be alluded to. An increase in the rapidity of the circulation means an increased flow or tendency of blood to the diseased parts, involving, as it does, a greater activity of these parts. This is temporarily noticeable in every case of phthisis pulmonalis coming to higher altitudes, and is evidenced by an increased expectoration. This, as we have said, may be beneficial by assisting to remove the morbid products; but in enfeebled cases, where the ravages of the disease are great, it may be highly injurious in assisting the already great breaking-down of the tissues. Again: there is an increased demand for oxygen dependent on all of these causes, and, in cases where the amount of lung-tissue involved is so great as to cause a considerable embarrassment of the respiration, this additional strain is not desirable.

2. *Effect on respiration.* — We must now study another effect produced upon the system by an increase in elevation, and that is, the effect produced upon the respiration. Here, too, we shall have to speak of gross results, and leave minutiae unexplained.

Experience shows that the respirations are deepened and fuller, and that they are, at first, at least, increased in number.

This can be explained somewhat in the following way. The nervous action, the effect upon the respiratory centre, etc., is so complicated, that, despite its importance, we shall leave it without attempting its solution; and we shall only attempt an explanation of the quasi physical or mechanical results.

The lungs are elastic bags suspended in a closed cavity. During inspirations the respiratory muscles draw the ribs upwards, enlarge the cavity, and produce a partial vacuum, in consequence of which the air rushes in to fill up this vacuum, and the lungs are inflated.

It is evident that in inspiration the respiratory muscles, in raising the chest-walls, displace a certain amount of air, and overcome a certain resistance due to atmospheric pressure, and that these muscles, accustomed to exert a given amount of force to overcome this resistance (which may be roughly measured by the difference between the positive pressure on the outside and the negative pressure on the inside of the chest-walls), would continue to exert this force, even though the resistance were diminished. As a result of this, we should expect either a greater expansion of the chest from the same expenditure of force, or an increase in the number of inspirations.

The beneficial results of a greater depth of inspiration will be more clearly seen if we contrast it with the bad results of diminished respiration. Ruehle, in Ziemssen's Cyclopaedia, says, —

"The diminished respiration in the upper parts of the lungs, and the exaggerated respiration in the lower parts resulting from this cause, serve to explain the very general fact that pulmonary consumption almost always begins at the apices of the lungs. But there is probably another cause in the peculiar position of these parts. They project from three to four centimetres above the clavicles; and this projecting portion, being situated outside the chest, is subjected to the pressure of the external air. The supraclavicular region sinks in during deep inspiration, and consequently the inspiratory expansion of the apices is less than that of other parts of the lungs."

It is evident, if Ruehle be right, that a diminution of atmospheric pressure means a greater expansion of the apices, due to a diminution of atmospheric pressure bearing on those parts, and also a greater expansion of the entire chest.

There is, however, a theory often advanced, that the greater depth of respiration is due to the fact, that, in consequence of the diminution of the amount of oxygen dependent upon the decreased atmospheric pressure, an individual will have to breathe more frequently and deeper to gain the amount of oxygen necessary for aerating the blood. The theory, it seems to us, is misunderstood, and the question needs investigation.

We have shown that there is an increased demand for oxygen dependent upon an increased tendency of the blood to the lungs.

It is known, also, that the transpiration of gases through tubes, which the bronchi really are, is hindered by a diminution of pressure, and that in consequence of this, in a given time, under the same conditions of expansion, etc., less air will enter the lungs at 5,000 feet elevation than at sea-level. This is another cause why the respirations should be either deeper or more frequent.

It is further known that the osmose of gases through a thin septum, as in the lungs, is less rapid the less the pressure, or, in other words, that the rapidity of the osmose of gases is dependent upon the pressure to which they are subjected. This being so, as the density of the oxygen and carbonic acid in the blood is nearly constant, if the density of these gases in the air be diminished, there will be an effect produced upon the rapidity of their osmose. In the case of oxygen, it is claimed that an individual will get less of it at 5,000 feet elevation than the system requires, and that, unless the conditions of respiration be changed, there will be a 'starvation of oxygen,' i.e., an asphyxia. In consequence of all this, it has been claimed that a greater depth and frequency of respiration is demanded to meet this want.

In regard to the osmose of oxygen, we know, that, even though there be a hindrance due to the diminished density of the gas in the air, there is still, on the other hand, an increased rapidity of the circulation, which would favor osmose; and it may be assumed that the effects of these two conditions counterbalance one another.

In regard to a starvation of oxygen being produced by a diminution in the amount of the gas at a higher elevation, the *rationale* is somewhat as follows: there exists in the atmosphere, under all pressures, 23 parts by weight of oxygen. At sea-level, there are 130.4 grains of the gas in every cubic foot, while, at 5,000 feet, this amount will be diminished one-sixth, so that there will only be 108.6 grains to the cubic foot. The question then is, whether a density of 108.6 grains to the cubic foot of air will produce a starvation of the gas in the human economy.

It has been estimated that the tension of the oxygen of the venous blood of the dog is 2.9%, or 22 mm., of mercury. It has been further estimated that the tension of the oxygen of the pulmonary air-cells is at least 10% of the atmospheric pressure, which, at 5,000 feet, would amount to 63.3 mm. of mercury; so that it is evident, that, even under this diminution of pressure, the difference between the density of the oxygen in the inspired air and in that of the venous blood brought to the lungs is sufficiently great to admit of a free osmose.

Further than this, we know that the amount of tidal air passing in and out of the chest of an average man is 500 cc., or 31 cubic inches. Allowing 17 respirations to the minute, this will make 510 litres, or 18 cubic feet, of oxygen inspired *per horam*. At 5,000 feet this air would contain 1,955 grains of oxygen. Now, the absolute absorption of oxygen at sea-level is only five per cent of that contained in the air, and the amount that is absolutely needed each hour, at sea-level, is only 117 grains. As the absolute demand for oxygen is only 117 grains each hour, and as the actual amount contained in the inspired air at an altitude of 5,000 feet is, for the same time, 1,955 grains, it is evident that here, again, the supply is greatly in excess of the demand, and that the term 'starvation of oxygen,' as explanatory of the increased depth and rapidity of the inspirations at high altitudes, is a misnomer.

But in addition to the absorption of oxygen there is the elimination of carbonic acid to be accounted for. It is evident, that, as the tension of the gas in the venous blood coming to the lungs is nearly constant, any diminution of its tension in the air will favor its osmose from the blood to the air, and that the effect produced upon the osmose of this gas by rise of elevation is the reverse of the effect upon the osmose of oxygen.

In concluding this part of our subject, we wish to emphasize the fact that we think that the benefit to be derived from simple elevation, in cases of phthisis pulmonalis, is to be attributed largely to the greater depth of the inspirations, and consequently to the greater distension and activity of all parts of the lungs (the diseased apices as well as the healthy bases), and to the increased elimination of morbid products brought about by the increased rapidity of the circulation.

3. *Ozone.* — In addition to the foregoing reasons for favoring a high altitude in the cure of phthisis, we wish to consider, further, the influence of elevation upon the ozone of the atmosphere.

The assertion is generally made, that, as "we ascend heights, the amount of the ozone rapidly increases;" and yet there does not seem to have been any direct experimentation on this point. If there be more free ozone, it may be due, not to any increased production over that of lower levels, but rather to a diminished consumption. Further than this, the starch and iodide test is so dependent upon other elements than the simple presence of ozone, that it is not thoroughly reliable. It is also open to the error of reacting to substances other than ozone. Still, admitting the statement that there is more nascent ozone at high elevations, the explanation of its action in the cure of phthisis is still to be sought. Some rather visionary theorists, as it seems to the writer, claim that it finds a direct admission to the diseased spots in the lungs, and, by its poorer oxidizing, it burns up *in loco* the morbid products.

We should rather attribute its influence to the fact, that, where ozone exists free, there is no decomposing matter to be oxidized. It seems to us to be indicative of the existence of pure air, rather than a direct agent in destroying the morbid products in the lungs.

4. *Immunity from phthisis.* — Another argument in favor of elevation in the cure of phthisis is, that at certain heights there exists an immunity from the disease. The disease is not endemic at such elevations.

This is in the nature of negative evidence; but it is certainly valuable as an element of prophylaxis, and we think that it can be applied as an argument in favor of cure. Ruehle (*op. cit.*) says, "A height of *at least* 1,800 or 2,000 feet seems to be requisite for this purpose. Phthisis is rare on the Hartz, Styrian (in Purzgau), and Swiss mountains." Jaccoud (Flint's Practice of medicine, p. 296) "states that the observations for fifteen consecutive years warrants him in asserting, that, in Alpine situations elevated 4,000 feet, tuberculosis is unknown; and especially is this true of villages at an elevation of 5,500 feet." Dr. Irwin reports for Fort Defiance (6,500 feet), north-western New Mexico, "During a service of some seven years in New Mexico and Arizona, I never saw or heard of a case of tuberculous disease amongst the native inhabitants of those territories." And Dr. Denison, in his work entitled 'Rocky Mountain health resorts,' writes, "After having quite thoroughly canvassed the subject among physicians of Colorado, I place the altitude of approximate immunity of this state at 6,000 feet."

Taking a mean of all these quotations, we may safely assert, that, broadly speaking, an altitude of from 5,000 to 6,000 feet affords an approximate immunity from this disease.

5. *An aseptic atmosphere.* — Lastly, we will speak of the influence of elevation in the cure of phthisis in producing an aseptic atmosphere. In these days of germ-theories and of Koch's experiments, we cannot but give emphasis to this element of antisepsis as an element of prophylaxis and cure of phthisis. Professor Tyndall's experiments show the abundance of germs floating in the air at sea-level, and an entire absence of such germs at the altitude of the 'Belle Alp' hotel (7,000 feet). Whether a lower elevation will furnish this aseptic atmosphere has not been proven experimentally; but it would seem to be reasonable to argue that an elevation corresponding to that of immunity from phthisis would furnish such an atmosphere.

Résumé. — There are other elements, such as humidity of the air, temperature, precipitation, etc., more or less dependent upon elevation, which we shall have occasion to speak of more at length. But, to make a *résumé* of our study to this point, we can say that a rise in elevation increases the heart-beat and the rapidity of the circulation, thereby hastening the absorption of the morbid products in phthisis, and increasing the metamorphosis of tissue, and hence the vital force; that it likewise produces greater depth of respirations, and a more healthy action of the diseased portions of the lungs; that it gives a purer air, and affords an approximate immunity from the disease; and, finally, that it affords an aseptic atmosphere, in which the Bacillus tuberculosis does not exist. The extent of elevation desirable for the production of this effect can be stated to be at least 5,000 feet.

Having arrived at these conclusions, it remains for us to apply them to our subject. By consulting table I., columns i. and ii., it will be seen, that, of all the resorts for the cure of phthisis in this country, the eastern slopes of the Rocky Mountains alone furnished the desirable elevation. The distance between Denver and Santa Fé is in the neighborhood of 375 miles in extent. Throughout this whole extent, pleasant locations for invalids are to be found at elevations varying from 5,000 to 6,000 feet.

(To be continued.)

HISTOLOGY OF INSECTS.

Inspired by Weissmann's well-known researches on the post-embryonic development of insects, Viallanes has studied the structure and changes of various tissues, principally in Musca vomitoria, but also in other insects during their metamorphoses. His results occupy nearly an entire volume,[1] and make an important addition to knowledge, the more welcome because the author deals chiefly with those tissues which have heretofore been least worked

[1] Vol. xiv. sér. vi. of Ann. sc. nat., zool.

upon. The long memoir embodies a large number of valuable data, the outcome of work which we believe to be thorough and careful. The collation of the literature is good, but not complete, some omissions being important. We are unable to give here more than the chief general conclusions.

The skin of the larvae studied consists of a single layer of large flattened cells, covered externally by the hard chitinous cuticula (containing lime in Stratiomys), which is smooth in Musca and Eristalis, but divided in Stratiomys into fields corresponding to the cells. Below the cells, and lying directly against them, is a thin anhistic membrane, which is comparable to the basal membrane in crustacea and adult insects.

The peripheral nervous system is of great interest. Between the integuments and the muscles of the larvae are found peripheral ganglia, which do not belong either to the ventral chain or to the stomatogastric system. No analogous observation has hitherto been made upon insects. The peripheral ganglia of the larva of Tipula are very remarkable from their regular disposition and their symmetry: there is a pair in each segment. Those of Musca are irregularly scattered between the skin and the muscles. Analogous ganglia are found in Eristalis, but are localized in the plexus, whence spring the nerves of the special sense-organs in the anterior region of the body. In the description of the peripheral nerves the author adds little to what was previously known.

The sensory nerves end in two ways, — either by a connection with sensory hairs of the epidermis, or with free terminations. In the former case the axis-cylinder dilates, at the base of the sensory hair, into a bi-polar ganglion cell. The sensory hair is a conical hollow process of the cuticula. It is secreted by a special, large, slightly modified epidermal cell, the protoplasm of which fills the cavity of the hair, and lines its base. The distal prolongation of the bi-polar cells unites with the protoplasm of the hair-cell, and does not run directly to the hair. This apparatus appears to subserve touch, smell, etc. The free terminations are found beneath the epidermis, as thread-like prolongations of a very rich dermal plexus, formed by very numerous multi-polar anastomosing nervous cells. (Besides the description of similar structures in other animals cited by Viallanes, *cf.* Canini and Gaule, Science, ii. **279**.)

Involuntary striated muscles. The larval heart is histologically comparable to a vertebrate capillary, being formed of flat cells soldered border to border. In the protoplasm of these cells, muscular fibres are formed, so that the cells are at once comparable to the endothelium and muscularis of the capillary. Within each single cell the fibrilla begins and ends with a thin disk or stria; therefore the space between the two disks is the unit of the fibril. In young larvae the heart is a simple tube without lateral openings. The striated muscles of the digestive tube are probably histologically identical with those of the heart, i.e., modified single cells; but Viallanes was unable to make out the cell-limits. In the walls of the stomach of Tipula is an intramuscular ganglionated nerve-plexus, which probably innervates the muscles; but the final terminations were not seen. This is regarded as confirmatory of Ranvier's law (*Leç. d'anat. génér.*, 1880, 463).

In regard to the voluntary muscles the following conclusions are drawn: the fibrillae of insects are homologous with those of vertebrates, although the latter are indivisible, while in insects certain fibrillae (of the wing-muscles) may be decomposed into fibriculae. In insects, as in vertebrates, the fibrillae are united into 'colonettes,' or little clusters, being closely cemented together by a homogeneous and continuous substance, into which neither protoplasm nor nuclei ever penetrate. In vertebrates a large number of colonettes are united within a common envelope, the sarcolemma, to form the fibre or primitive bundle. In insect larvae this disposition is maintained, but in the wing-muscles the sarcolemma is absent; the primitive bundle then consists of a few colonettes (Musca), or even of one colonette only (*cf.* Ciaccio, Science, i. **247**, whose paper is not cited). In the leg-muscles there is but a single colonette in each fibre, and the sarcolemma is scarcely developed. As regards the motor plates the following points are noted : 1°. In the larva of Stratiomys chamaeleon, each of the fibres, constructed on the vertebrate type, has several Doyère's cones, to the summit of each of which runs an axis-cylinder accompanied by a nucleated sheath. Before innervating the muscle, the nerves form a plexus; in the cone the axis-cylinder forms a terminal arborization by successive dichotomous branchings inside the sarcolemma; the fundamental substance contains neither granular matter nor nuclei. 2°. In Tipula there is a similar arrangement, but only one cone to each fibre; the terminal arborization is much more extended, and bears nuclei; and the basal substance of the cone is granular, and nucleated as in the terminal plates of Amniota. 3°. In the caudal muscles of Eristalis and the leg-muscles of Dytiscus, each fibre of which contains only a single colonette, the motor nerves form no arborization, but break up into their constituent fibrils as soon as they reach the sarcolemma.

The second part of the memoir deals with the very remarkable changes in the larval tissues at pupation. The corpuscles of the blood of the larva are embryonic cells analogous to the leucocytes of vertebrates, and are found in the same form in the pupae. The muscular fibres of the larva disappear at the commencement of pupal life, and in two ways: — First, by 'évolution régressive :' the nuclei of the muscle become spherical, and each surrounded by a coat of protoplasm, thus becoming a muscle-corpuscle, which proliferates, and gives rise to a great number of rose-colored granules, which multiply until the muscular substance entirely disappears, as if it supplied nutriment to the granules; these last finally separate, and spread themselves through the body cavity. Second, by degeneration: the nuclei keep becoming rarer until they all disappear, and meanwhile the contractile substance disappears as if dissolved away on the outside. In consequence of these processes, the body cavity is charged with a quantity of matter resembling the vitelline elements of birds. The cells of the so-called fat-body produce, during the first days of pupal life, numerous granules, which enlarge, and are ultimately set free by the rupture of the cell-membrane. These granules arise independently of the nucleus, but closely resemble small cells. The cells of the tracheae and salivary glands do not disappear at the time of metamorphosis, as has been thought, but, on the contrary, they proliferate by endogenous cell-formation, the parent cell being first enlarged; the parent nucleus is finally discharged; the embryonic cells thus generated separate, and fall into the general body cavity. The *körnchenkugel* produced by pupal histolysis, and described by Weissmann, are of two kinds, and do not arise from the disintegrated matter, as supposed; but the smaller are derived from the muscle-corpuscles, the larger from cells of the fat-body. The epidermis of the larval head and thorax dries up and falls off. It is not immediately replaced by the definite cell-layer, but first by a thin cuticle, which Viallanes considers to be probably the thickened basement membrane of the larva.

Part third treats of the histogenesis of the tissues of the imago. The skin of the head and thorax is developed from Weissmann's imaginal disks. In the description of these, Viallanes follows Ganin in general, but he thinks that the mesoderm of the disks is formed at the expense of some of the embryonic cells in the body cavity. Other points are also brought forward, among which we note especially that the wing of the pupa contains at first numerous tracheae, which disappear before the end of the stage. In the abdomen, also, there are imaginal disks, four in each segment, and formed by local thickenings of the epidermis; all other parts of the epidermis or hypoderm degenerate, and are resorbed. The disks form two layers, the outer making the new epidermis, and the inner the mesoderm; the disks grow at their borders until they everywhere meet, and form a continuous tissue. The method of regeneration is the same as in the thorax, except that the disks are developed later: the difference assumed by Weissmann and Ganin is not real. The author compares the imaginal disks with the plates in Pilidium.

The internal muscular mass of the thorax is derived from a single anlage, composed of little cells embedded in a small amount of homogeneous basal substance. This anlage then separates into six cords, corresponding to the definite muscles; these grow by peripheral accretion; the muscular substance is then differentiated around the cells, which are disposed with great regularity in the midst of the colonettes, becoming, in fact, the muscle-corpuscles (the necessity of omitting a fuller account is much regretted. — *Rep.*). The muscles of the legs are derived from the mesoderm of the imaginal disks; the general process of their histogenesis, despite many interesting differences, is the same as that of the wing-muscles. The author makes an excellent comparison between the unicellular muscles (heart, stomach) and the pleuricellular (wings, legs), or, as we might name them, the mesenchymal and myothelial muscles.

Nearly a fifth of the entire memoir is devoted to the development of the eye. The brief *résumé* (p. 302–305) is the most succinct and perfect account of the structure of the compound eye with which we are acquainted. In the first section the structure of the developed eye of the pupa, before it becomes pigmented, is described. The following is the author's table of the parts of the visual apparatus: —

Œil composé . . .	Cornée à facettes. Couche des cellules cristalliniennes. Couche des rétinules ou rétine. Limitante postérieure de l'œil composé.
Couche des fibres post-rétiniennes.	
Lame ganglionnaire	Limitante antérieure de la lame ganglionnaire. Couche des cellules ganglionnaires. Couche des fibres en palissade. Limitante moyenne de la lame ganglionnaire. Couche des fibres nucléées. Limitante postérieure de la lame ganglionnaire.
Couche des fibres préganglionnaires.	
Ganglion optique .	Névrilemme. Couche des cellules en chapelets. Croissant du noyau central. Éventail du noyau central. Écorce grise du ganglion optique.

Concerning the development of the eye, we give the following conclusions. In the larva, before metamorphosis, the eye is represented by three parts, — the imaginal disk of the eye proper, the neural stem, and the optic ganglion. The disk of the eye comprises the same three layers as the other imaginal disks. Before the metamorphosis of the larva, the superficial cells of the exodermic layer become enlarged and elongated, and acquire a strong affinity for coloring-matters; they are the optogenic cells. This change begins in the centre, and spreads towards the periphery of the disk. The mesoderm of the disk of the eye, unlike the other two layers, is different from the corresponding portion of other disks, since it is composed of fine nerve-fibrillae mingled with nuclei; by teasing, it can be shown that each fibril is connected with the inner end of an exoderm cell. The nervous stem unites the disk of the eye with the optic ganglion, and is composed of the nerve-fibrils mingled with nuclei. The optic ganglion is constituted by the outer portion of the brain; its nucleus consists of white, its cortex of gray, matter; in the lateral portion of the cortex, is the complex anlage of the *lame ganglionnaire*, in which all the principal constituent parts of the definite *lame ganglionnaire* can be recognized. At the moment of metamorphosis the following phenomena occur: the provisory layer of the disk of the eye disappears, the exoderm enlarges, its borders unite with the neighboring disks, its cuticle becomes the faceted cornea, and its optogenic cells each form, by the known process, an elementary eye. The anlage of the *lame ganglionnaire* emigrates from the optic ganglion, then enlarges, and spreads out so as to intervene between the ganglion and the eye. The details of the differentiation of the *lame* are carefully described.

I cannot conclude this notice without referring to the admirable manner in which this valuable memoir is written, and the great clearness with which the facts and conclusions are presented.

CHARLES S. MINOT.

EXPERIMENTS TO DETERMINE THE GERMICIDE VALUE OF CERTAIN THERAPEUTIC AGENTS.

In the *American journal of medical sciences* for April, Dr. Sternberg gives an account of his study of this important question. The objects of the author were, —

To ascertain the exact value, as germicides, of some of the agents most frequently employed in medical and surgical practice, with a view to the destruction of pathogenic micro-organisms, hypothetical or demonstrated.

To compare this value, established by laboratory experiments, with the results of clinical experience, for the purpose of ascertaining what support, if any, the germ-theory of disease receives from modern therapeutics.

Assuming that the active agent in infective material is a living micro-organism, or 'germ,' disinfection will be accomplished by those chemical agents only, which have the power of destroying the vitality of this organism. We require to know: —

a. What is the absolute germicide power of various disinfecting agents, in order to select the best with a view to economy and efficiency;

b. Are all disease-germs destroyed by these agents in the same proportion? and, if not,

c. What agents are the most available for special kinds of infective material?

In therapeutics we should know, in addition to this: —

d. What is the minimum quantity of each of these agents which will restrict the multiplication of each specific disease-germ in a suitable culture-medium? — this with reference to medication, with a view to accomplishing a like result within the body of an infected individual.

Evidently, any thing like a complete answer to these questions is quite impossible in the present state of knowledge, and we must content ourselves with such partial or approximate answers as can be obtained by laboratory experiments upon the comparatively small number of pathogenic organisms which abound in organic liquids undergoing putrefaction.

The experiments were conducted by using small sealed flasks containing bouillon free from micro-organisms. The smallest quantity of a fluid containing such organisms introduced into one of the flasks would cause it to 'break down' within twenty-four hours, it being exposed during this time to a temperature of 100° F.

To test the germicide power of a chemical reagent, living bacteria are subjected to its action in a known proportion for a given time, and are subsequently used to inoculate sterilized bouillon in one of the flasks. Failure to multiply in this fluid, when exposed for twenty-four hours or more to a temperature of 100° F., is evidence that reproductive power — vitality — has been destroyed by the reagent used. On the other hand, failure to disinfect, i.e., to destroy the vitality of the bacterial organisms used as a test, is shown by the 'breaking-down' of the culture-fluid.

Standard solutions of the reagents to be tested are prepared with distillled water. The germs are exposed, in small glass tubes, to the action of these agents for two hours. The tubes are sterilized in the flame of an alcohol-lamp immediately before each experiment; they are open, and covered by a bell-glass during the time of exposure.

At the end of the time of exposure, a small quantity of the fluid from one of the tubes is introduced into a flask containing sterilized bouillon, and this is exposed to a temperature of 100° F. for twenty-four hours.

The micro-organisms which have been used in the experiments herein reported, to test the germicide power of the reagents named, were obtained from the following sources: —

a. A micrococcus from gonorrhoeal pus.

b. A micrococcus from pus obtained from an acute abscess (whitlow) at the moment that it was opened by a deep incision. This micrococcus is morphologically identical with the preceding.

c. A pathogenic micrococcus, having distinct morphological characters obtained from the blood of a septicaemic rabbit.

d. Bacterium termo, and other bacterial organisms (micrococci and bacilli) from 'broken-down' beef-tea which had been freely exposed to the air.

In the following table, which is arranged according to the germicide value of the agents named, all experiments are given in which the micrococcus from pus was used as a test.

Mercuric bichloride (0.005 per cent), efficient in the proportion of one part in	20,000
Potassium permanganate (0.12 per cent), efficient in the proportion of one part in	833
Iodine (0 2 per cent), efficient in the proportion of one part in	500
Creosote (0.5 per cent), efficient in the proportion of one part in	200
Sulphuric acid (0.5 per cent), efficient in the proportion of one part in	200
Carbolic acid (1 per cent), efficient in the proportion of one part in	100
Hydrochloric acid (1 per cent), efficient in the proportion of one part in	100
Zinc chloride (4 per cent), efficient in the proportion of one part in	50
Tinc. ferri chloridi (4 per cent), efficient in the proportion of one part in	25
Salicylic acid dissolved by sodium borate (4 per cent), efficient in the proportion of one part in	25
Caustic potash (10 per cent), efficient in the proportion of one part in	10
Citric acid (12 per cent), efficient in the proportion of one part in	8
Chloral hydrate (20 per cent), efficient in the proportion of one part in	5

The following-named reagents, as far as the experiments go, are not shown to have any germicide value; viz., —

	Per cent.
Fowler's solution failed in the proportion of . . .	40
Sodium hyposulphite failed in the proportion of . . .	32
Sodium sulphite, exsiccata, failed in the proportion of .	10
Ferric sulphate (saturated solution) failed in the proportion of	16
Potassium iodide failed in the proportion of . . .	8
Liq. zinci chloridi failed in the proportion of . . .	8
Boracic acid (saturated solution) failed in the proportion of	4
Zinc sulphate failed in the proportion of	20
Sodium borate (saturated solution) failed in the proportion of	4
Sodium salicylate failed in the proportion of . . .	4

Having ascertained the germicide value of certain reagents for a single micro-organism, the question arises as to whether we are justified in assuming that other organisms of the same class, and especially pathogenic bacteria, will be destroyed by the same reagents in like proportion, or, in other words, whether we can generalize from the data obtained. It is evident, that, if each of the reagents named gives identical results with several distinct species of bacteria, we shall be justified in assuming that the value obtained will be constant for other organisms, known or unknown, of the same class; whereas, if marked differences are found as to the vital resistance of different bacterial organisms to these reagents, no generalization will be possible, and the value for each distinct organism of the class can only be fixed by experiment. To solve this question, experiments have been made as follows: —

a. Upon the micrococcus of pus.

b. Upon the micrococcus of septicaemia in the rabbit.

c. Upon bacterium termo, in its active motile stage, as found in a fresh culture.

d. Upon the bacteria in broken-down beef-tea which had been freely exposed to the air, and in which all active development had ceased.

The results show, that, in general, those reagents which destroyed the vitality of the micrococcus from pus are destructive to organisms of the same class, and that their relative value as germicides is not changed when a different micro-organism is used as the test of this value. Moreover, the reagents which were found to be practically valueless as germicides in the first series of experiments — e.g., ferric sulphate, sodium sulphite, and hyposulphite, boracic acid, etc. — proved to be equally without value when the test was extended to other micro-organisms of the same class. But the reagents found to possess decided germicide power have, in some cases, a different value for different organisms: in other words, the vital resistance of different bacterial organisms to the reagents in question is not in all cases the same.

Thus, sulphuric acid failed to destroy B. termo and the micrococcus from pus in the proportion of 0.25 %; but one-fourth of this amount (0.06 %) destroyed the vitality of the septic micrococcus.

Caustic potash destroyed the septic micrococcus in the proportion of 2 %, but failed to kill the micrococcus of pus in four times this amount (8 %). The value, as a germicide, of the solution of ferric sulphate and sulphuric acid in water, which has been extensively recommended by sanitarians as a disinfectant, evidently depends upon the sulphuric acid which the solution contains. To insure the destruction of all bacterial organisms and of the reproductive spores of those species which multiply by spores as well as by transverse fission, such a solution should be used in sufficient quantity to subject the material to be disinfected to the action of the acid in the proportion of at least five per cent for a period of two hours.

The quantity of carbolic acid used to accomplish the same result should not be less than five per cent, for it is necessary to keep on the safe side; and we do not know, at present, whether all of the pathogenic bacteria, hypothetical or demonstrated, form spores or otherwise. In the case of the anthrax bacillus and of Koch's bacillus of tuberculosis, this has been proved to be true; and we have ample experimental evidence to show that these reproductive bodies possess very great resistance to heat and to those chemical reagents which destroy bacterial organisms in their ordinary condition of rapid growth and multiplication by fission.

Evidently, therapeutic value — assuming the correctness of the germ-theory — cannot be gauged by germicide power alone, for it is possible that a reagent which possesses this power in but slight degree, or not at all, may nevertheless be capable of restricting the development of pathogenic organisms, and thus limiting their power for mischief.

The following table shows the percentage required to destroy vitality, and also that required to prevent the development of the micrococcus of pus: —

Reagent.	Percentage required to destroy vitality.	Percentage capable of preventing development.
Mercuric bichloride . . .	0.005	0.003
Iodine	0.2	0.025
Sulphuric acid	0.25	0.12
Carbolic acid	0.8	0.2
Salicylic acid and sodium biborate	2	0.5
Alcohol	40	10
Ferric sulphate	Failed in saturated solution.	0.5
Boracic acid		0.5
Sodium biborate		0.5

An inspection of the table shows that the potent germicides in our list restrict multiplication in quantities considerably less than are required to destroy vitality. In the case of iodine the difference is eightfold; in that of carbolic acid, fourfold; in that of sulphuric acid, twofold, etc.

We also see that the agents at the bottom of the list, — ferric sulphate, boracic acid, and sodium biborate, — in the proportion of five-tenths per cent, prevent the multiplication of bacterial organisms, and are consequently antiseptic agents of value, although in saturated solution they fail to kill these organisms.

In the case of ferric sulphate, and also of zinc sulphate and zinc chloride, this power to prevent the development of micro-organisms seems to be due to precipitation of the organic material in the nutritive medium rather than to any direct action upon the living organisms, which, as we have seen, are not killed by a far greater quantity of the reagent.

The conclusions at which Dr. Sternberg arrives, are, that the vital resistance of bacterial organisms to chemical reagents differs, within certain limits, for different species. And certain species show special susceptibility to the germicide action of particular reagents; e.g., the septic micrococcus to alcohol, and B. termo to boracic acid.

There is, therefore, reason for supposing that different pathogenic organisms may differ in like manner, as to susceptibility to the action of various reagents administered medicinally with a view to their destruction. Nevertheless, the comparative germicide value of the reagents tested is the same for the several test-organisms, and, allowing certain limits for specific peculiarities, it is safe to generalize from the experimental data obtained in the practical use of these reagents as disinfectants. But it must be remembered that the resisting power of reproductive spores is far greater than that of bacterial organisms in active growth (multiplication by fission), and the data obtained for the latter cannot be extended to include the former.

The antiseptic value of the reagents tested depends upon their power to prevent the multiplication of putrefactive bacteria; and this is not necessarily connected with germicide potency, for some reagents which fail to kill these micro-organisms are, nevertheless, valuable antiseptics, e.g., ferric sulphate and boracic acid.

Clinical experience has demonstrated the value of all the potent germicide reagents tested in one or more of the diseases which there is the most reason to believe are due to the presence of pathogenic micro-organisms in the *primae viae*, in the blood, or in the tissues; e.g., intermittent-fever, typhoid-fever, dysentery, erysipelas, syphilis, etc. The 'germ-theory' as to the causation of these diseases receives, therefore, very strong support from modern therapeutics; but the experiments do not justify the belief that any one of the reagents tested can be administered as a specific in germ-diseases generally. This also accords with the results of clinical experience, and makes it possible to believe that the specific, self-limited diseases are also 'germ' diseases.

LETTERS TO THE EDITOR.

The practical value of soil-analysis.

In *Bulletin* lvi. of the New York agricultural experiment-station, Dr. Sturtevant gives the reasons for which the station declines to make soil-analyses 'for the purposes of the individual farmer;' summarizing them in the statement that such ayalyses "can offer no solution of the problem of what fertilizer, and how much, to apply."

Were this statement made in a somewhat less general and absolute manner, I should have no fault to find with it; for in the case of the long-cultivated fields of the state of New York, which have been subject to indefinitely varied culture-conditiohs and the use of fertilizers, the cases in which chemical analysis alone would point with any degree of certainty to the true cause of failure to produce profitable crops would be exceptional; and the station would be likely to be overrun with requests for an indefinite amount of comparatively useless routine work.

But when Dr. Sturtevant broadly adds his denial "that analyses of soils can give us definite information concerning their productiveness," he seems to go beyond the limits justified by the record, and beyond what the context following would appear to show he intended to say. If the clause above quoted were to read, instead, "while denying that analyses of *cultivated* soils can give us definite information regarding their *present* productiveness," I should agree with him so far as the great majority of cases is concerned, — so much so, that it is only exceptionally that I undertake the analysis of a cultivated soil, but usually go back to its virgin ancestor for information as to its general character; and from this, and the usually simple history of its cultivation, pretty definite inferences as to the prominent wants even of a cultivated soil can in very many cases be deduced, as is proved by the practical results. Dr. Sturtevant's own statement as to the frequency and consequent practical importance of such inquiries would seem to justify the taking of some pains to approach its solution, before proclaiming an absolute *non possumus*.

As for virgin soils, which over wide areas have been subject to uniform or uniformly variable conditions, it is *a priori* reasonably presumable, and I think experience confirms the inference, that, other things being equal, the amount of available plant-food, and therefore the durability of a given soil under the usual culture, without replacement, is sensibly proportional to the plant-food percentages shown by the usual method of analysis. Whether or not other things are really equal can only be ascertained by intelligent examination in the field as well as in the laboratory; and soil-specimens taken by non-experts rarely fulfil this condition.

While, therefore, believing that Dr. Sturtevant's action in this matter is well advised under the circumstances, I nevertheless believe that my contrary practice in regions but sparsely or recently settled is at least equally well justified, and that the importance of affording the settler at least an approximate insight into the present and ultimate durability of his soil, and its general character and adaptations, is so great as to justify a considerable public expenditure, upon a well-considered plan carefully carried out by competent persons both in the field and in the laboratory, even with our present limited knowledge of the chemistry of soils — which, I cannot but remark, is not likely to be increased very rapidly if the composition of soils serving for culture-experiments continues to be ignored, as has so largely been the case heretofore. The prime importance of the presence of a certain minimum percentage of lime, for example, is manifestly so great, that no experimenter can afford to be ignorant of the presence or absence of a proper supply of that substance in his soil; and the cases in which analysis shows the extreme scarcity or extreme abundance of lime, phosphates, or potash, in virgin soils and subsoils, are far more frequent than the contemners of soil-analysis suppose. In the former case the practical value of the indication is too obvious to be overlooked, and is amply attested by the results following the application, e.g., of phosphate fertilizers in such cases. We might not be able to detect the addition thus made to the phosphates of the soil by the most careful analysis; but the fact that the soil is naturally poor in phosphates will remain a fruitful truth forever after.

I trust that the record which will be shown in the census report of cotton production, now in press, will form a convincing illustration of the legitimate uses of soil-analysis. E. W. Hilgard.

University of California, Sept. 1, 1883.

Do humming-birds fly backwards?

The Duke of Argyll, in his Reign of law (p. 145), lays it down in italics, that '*no bird can ever fly backwards*.' He mentions the humming-bird as appearing to do so, but maintains, that, in reality, the bird falls, rather than flies, when, for instance, he comes out of a tubular flower. But this morning, while watching the motions of a humming-bird (Trochilus colubris), it occurred to me to test this *dictum* of the duke; and, unless my eyes were altogether at fault, the bird did actually fly backwards. He was probing one after another the blossoms of a Petunia-bed, and more than once, when the flower happened to be low down, he plainly rose, rather than fell, as he backed out of and away from it. I stood within a yard or two of him, and do not believe that I was deceived.

It may not be amiss to add that the Duke of Argyll's objections seem to be purely theoretical, since the 'Reign of law' was published in 1866, and it was not till 1879 that the author came to America and saw his first living humming-bird.

Bradford Torrey.

Boston, Sept. 14, 1883.

Wright's ice-dam at Cincinnati.

I notice on p. 320 of Science, vol. ii. no. 31, an inaccurate report of what I said at the Minneapolis meeting, which does injustice both to Mr. Wright and to myself, and which I would beg to have corrected.

The reporter makes me speak slightingly of Mr. Wright's discovery of the ice-dam at Cincinnati, as not sufficing to explain our Pennsylvania terraces. On the contrary, I expressed my admiration for the discovery as furnishing precisely the explanation we need for the *local-drift* terraces of the Monongahela, and the *rolled-northern-drift* terraces of the lower Alleghany, Beaver, and upper Ohio rivers.

The reporter probably mixed this up with what I said afterwards respecting the *rolled-drift* terraces of eastern Pennsylvania, which only reach a height of 800′ A. T., in Northumberland county, and require some explanation, perhaps, quite unconnected with that which Mr. Wright certainly furnishes in a most satisfactory manner for the 800′ to 1,100′ A. T. terraces of the Ohio River basin. J. P. Lesley.

Second geological survey of Pennsylvania,
Philadelphia, Sept. 15, 1883.

Erratic pebbles in the Licking valley.

While engaged in tracing the outcrop of 'Clinton ore' in eastern Kentucky, in the fall of 1882, I became interested in the pebbles, which in certain localities, and up to a certain height, were very abundant in the surface-soil.

Most abundant were rounded quartz pebbles, probably from the millstone grit. Somewhat less abundant were fragments of chert, showing little or no wear derived from the sub-carboniferous limestone. Still less abundant, though by no means rare, were some from the carboniferous, often containing characteristic fossils. They were confined, so far as I could determine, to the valley of the Licking and its larger tributaries. Vertically, they range from the river-bottoms to the top of the table, formed by the upper Silurian rocks, which borders on the Devonian escarpment; so that these tables are quite uniformly covered with the material.

The distribution of the material is such as could only have been made while the valley was temporarily occupied by a lake. I was therefore led, though with some hesitation, to suppose that the glacier must have crossed the Ohio at Cincinnati, damming the river. I was not at the time aware of the labors of Mr. Wright in tracing the glacier across the Ohio.

Having now the certainty that there was a dam at the required point, I think I may have no hesitation in saying, that, during a portion of the glacial period, the valley of the Licking was occupied by a lake which overflowed laterally, and whose bottom became littered with materials brought from the mountains of eastern Kentucky by floating ice. They are most abundant where the ice may be supposed to have had freest access.

Terraces which might have been expected are wanting in the region in which my observations were made. Possibly they may be found in other parts of the valley, especially above; their absence in the region in question being due to the fact that only small portions of the region would have reached above the lake-level, which, by their disintegration, could furnish the material for terraces.

The overflow was probably to southward, but I could not search for it. Could it be traced, the amount of erosion might give some data for an estimate of time. G. H. Squier.

Trempealeau, Wis., Sept. 14, 1883.

Depth of ice during the glacial age.

In the issue of Science for Sept. 7, reporting my paper at Minneapolis, I am made to say, that, during the glacial period, the ice was indeed "600 feet over New England, and very likely of equal depth over the area to the west." I said 6,000 feet over New England. The evidences of glaciation are distinct upon the Green Mountains to a height of nearly 5,000 feet. The lower summits of the White Mountains, like Carrigain (which is 4,300 feet above the sea), are covered with transported bowlders; and there can be little question that some found by Professor Charles Hitchcock, within a few hundred feet of the summit of Mount Washington, were transported thither by glacial agency. Such is the evidence for New England.

For the region north of Pennsylvania and the Ohio River, direct evidence of such a great depth of ice is naturally wanting; but, according to Ramsay, glacial scratches are numerous upon the summit of Catskill Mountains in New York, at an elevation of 2,850 feet above the sea. In southern Ohio there are numerous places where the ice, within a mile or two of its farthest extension, surmounted elevations which are about 500 feet higher than the plains to the north of them. I see no reason why it should not have been as deep over the bed of Lake Erie as over the region to the north of the White Mountains, though there are there no glaciometers like Mount Washington to measure the height of the frozen mass.

G. Frederick Wright.

Oberlin, O., Sept. 13, 1883.

The 'stony girdle' of the earth.

In your issue of Sept. 7, just received, you are kind enough to insert a synopsis of the two abstracts of papers which I sent to the Minneapolis meeting. Allow me the space necessary to make a correction and some brief explanations. We are required to furnish these 'abstracts' to suit a printed form of small note size, which is apt to lead to small chirography: hence I suppose the mistake in reading and printing the title.

It should read, 'stony girdle,' and was in inverted commas to show that the name did not originate with me. My special object was to call attention to its being, in a great measure, the same belt which forms the prime-vertical when the pole of the land-centre at Mount Rosa is brought to the zenith. The unfavorable comments to which you allude have force as a general rule; namely, that closet geology is not comparable to observations in the field. Yet *all generalizations* may be called closet geology, as being the result of a large number of facts collected in the field, and compared subsequently. As it would, however, be presumptuous in any one to offer generalizations who had not had somewhat extended opportunities for observation, I may be permitted to mention, as some justification, those I have enjoyed. In North America my observations, partly in special work, partly during travel, have ranged from Rainy Lake, north of Lake Superior, to Saltillo, in Mexico, and from the Atlantic states to the head waters of the Gila, in Arizona. In the eastern continent, I travelled from the north of Scotland to Cairo in Egypt, ascending Etna, and spending the vacations of three summers, during college-life, in Switzerland among its mountains, ranging subsequently from western France to the Crimea. In 1824 I saw the 'Perte du Rhône,' where that river disappeared for miles, and then re-appeared,—a phenomenon no longer to be seen, as the superincumbent rocks, some years later, caved in, and converted the subterranean into a subaerial bed for that fine stream.

In 1829 I visited the scene of the catastrophe at New Madrid; and while granting a local subsidence for the immediate cause, as claimed in the able paper by Dr. Macfarlane, of which you give an abstract, I am compelled to believe that the remote cause was due to a seismic movement, felt, as Mallet states, at least two hundred miles from New Madrid, and, indeed, affecting large and more distant areas about that time, as mentioned in Key to geology, p. 77.

These opportunities, in connection with the specimens and notes of reference brought home, permit a review of general geology, which I thought might enable me to present to the student of geography and geology some broad principles and truths into which the details subsequently obtained by him might be appropriately fitted: hence the paper read at the Boston meeting, showing that the eastern trend of each continent was distant one-fifth of the circumference of the globe from its adjoining continental trend; also that each continent presented a central focus, from which a circle with radius of 36° would embrace the land proper, — sometimes excluding a peninsula, such as Hindostan, sometimes including adjacent islands, as those of Madeira, Canary, and Cape Verd, as belonging to the main continent, Africa. The Montreal papers were designed to show the important seismic fissurings radiating from the pole of the land-centre; also the relation between solar and terrestrial dynamics, where seismic phenomena are transmitted along great circles coinciding with the sun's apparent path, or along belts of the earth's crust which are secondaries to the ecliptic.

The occurrences of the last few weeks seem to corroborate the generalization offered, inasmuch as Ischia is on the 30° fissure from Rosa, at no great distance; while Java and the Straits of Sunda, as well as Guayaquil, more recently disturbed, are on or close to the prime-vertical.

If these generalizations belong rather in the category of instruction for the student than of contributions to science, perhaps my twenty-five years of natural-science teaching may present some excuse. Certainly, my great aim and desire are to arrive at important scientific truths, especially general laws in the dynamics of our globe. RICHARD OWEN.

Mr. Morse's papers at Minneapolis.

A number of errors have been made in the report of my papers which were read at the Minneapolis meeting.

In the paper on an apparatus for warming and ventilating apartments, the statement that the temperature of a hall was raised 40° above the outside temperature is incorrect. I said that the air, as it entered the room *from the heater*, had been raised 40° above the outside air.

In the paper on the methods of arrow-release, I spoke of the English method, which was probably that of the Saxon, and said that American archers followed the English. The Japanese never use thumb-rings, to my knowledge. The Koreans, Chinese, Manchu Tartars, and Persians use the thumb-ring.

A more serious mistake occurs in the report of my paper on the indoor games of the Japanese. I said very distinctly, that, in the game of chess, pieces captured could be used by the capturer against his opponent. In comparing the Japanese games with ours, I made no allusion to seven-up or whist. With every one I regard whist as next to chess in character as a highly intellectual game.

You will confer a great favor by publishing these corrections. EDW. S. MORSE.

Salem, Mass., Sept. 16, 1883.

Evidences of glacial man.

In SCIENCE, no. 32, p. 384, the statement is made, respecting Miss Babbitt's Minnesota finds, that "thus far, at best, the glacial workman is known only by his chips." What better evidence, I would inquire, is needed, if those chips are of artificial origin?

Is not this sufficient? Are not shavings and sawdust as good evidence of men working in wood, today, as are the planes and saws they use? From the very nature of the case, it is unreasonable to find as abundant and easily recognized evidence of man in drift-deposits as upon the surface-soils; yet this is what some of those present at the Minneapolis meeting of the American association for the advancement of science seemed to require.

In the case of the 'paleolithic' implements of the Delaware River valley, other evidence than the chipped stones has been found. The human tooth, lately described in detail in the Proceedings of the Boston society of natural history, is, of itself, evidence of man's presence at the time the gravels, in which it occurred, were laid down. Other human remains have also been found.

A word, too, with reference to the implements. These are nearly all as unmistakably artificial as the most finished arrow-head. Objects of identical character are found among the relics of the recent Indians, and are not questioned. Why, then, should a similar class of objects, found in gravel-deposits that antedate the superincumbent surface-soils, be questioned?

There is no doubt overshadowing the existence of man in the Delaware valley as long ago as the close of the glacial period: his presence, then, is not merely 'a theory advanced by Dr. Abbott,' as you suggest, but a fact susceptible of actual demonstration.

Professor Mason, in his address (in the same issue), asks, "What is the real import of such discoveries as those of Dr. Abbott and Professor Whitney in establishing the great antiquity and early rudeness of the American savage?" Speaking for myself, I would suggest that his question contains its answer. My discoveries have established the glacial age of man on the Atlantic seaboard of America, and at that time his culture was that stage known as 'paleolithic.'

Chas. C. Abbott, M.D.

Trenton, N.J., Sept. 18, 1883.

THE ALPHABET.

The alphabet, an account of the origin and development of letters. By Isaac Taylor, M.A., LL.D. 2 vols. London, *Kegan Paul, Trench, & Co.*, 1883. 16+358; 398 p. 8°.

Mr. Taylor has produced an admirable work on the interesting subject of alphabetic writing. It abounds in wealth of collected material, down to the very latest discoveries (some of them of the utmost importance). By lavish and well-chosen illustration it puts this material before the apprehension of the reader or student with the most desirable clearness; and its digest and criticism of former opinions is made with impartiality and independence of judgment, while the author adds abundantly of new views, and arguments to support them. No other existing work of a like character can bear any comparison with it; and it deserves to have, as it doubtless will attain, a wide circulation and popularity.

In the main, these volumes are filled with the history of our own alphabet and its relatives, or of the ancient Phoenician with its descendants and probable ancestor, since other systems of alphabetic writing are comparatively insignificant in number and in importance. The Chinese characters are not alphabetic, although one or two derivatives from them (as the Japanese *kata-kana*) have that character. The cuneiform mode of writing ended its career in an alphabetic system, the Persian; but all the peoples using cuneiform passed over, more than two thousand years ago, to the side of the Phoenician. There have been other hieroglyphic schemes, in the old world and the new, that made advances, no one can say just how far, toward alphabetism; but they are long since perished without descendants. All these, together with such theoretic basis as he chooses to lay for the science, Mr. Taylor despatches in the first chapter (seventy pages) of his first volume; the rest is devoted to our alphabet: the various kindred Semitic forms of it being treated in the former volume, and the Indo-European forms, with the few outside stragglers, in the latter, under the divisions of Greek, derivatives of Greek (Italian, Coptic, Slavonic, Albanian, Runic, Ogham), Iranian, and Indian. The method is not to be condemned, although we might have desired a more ample theoretical introduction. The fundamental principle of alphabetic history is distinct, and briefly statable: all writing begins necessarily with the depiction of scenes and objects, or is purely pictorial; it everywhere tends to pass over into a depiction of the names of objects; and, when it has fully reached that condition, it has become alphabetic. There can be no such thing as an alphabet not starting from a pictorial stage, any more than a spoken language without an initial imitative root-stage. But while in language we can only get back by inference to such a state of things, because the beginnings of language are so remote from us, in writing we find the pictorial stage abundantly represented.

Whether that stage is discoverable in the actual history of our own alphabet, is a question not yet absolutely settled. Every step by which our familiar letters go back to the primitive Semitic alphabet, usually called by us Phoenician, is traced out with the utmost distinctness. The Phoenician is purely, though defectively, alphabetic. It must, then, have come from a pictorial original. Three such systems of writing are found in its neighborhood, — Egyptian, cuneiform (the perhaps sufficient, though rather scanty, evidences of whose hieroglyphic origin are given by our author), and the recently discovered and still obscure Hittite. Did it come demonstrably from one of these, or has it an ancestor now lost to us? As is well known, De Rougé's work, published less than ten years ago, attempted to show its derivation from Egyptian, from hieratic characters, of known hieroglyphic originals; and his view is widely, though by no means universally, accepted. Mr. Taylor is a firm believer in it, and sets it forth with much clearness and force. We find ourselves unable fully to share his conviction. De Rougé endeavored to prove more than was reasonable, and found it so easy to prove all he undertook, that his very success casts a shade of unreality over the whole comparison. We may allow that his identifications are both possible, and, as a whole, plausible quite beyond any others yet made. Yet whereas the derivation of the Greek or of the Arabic alphabet, for example, is past all doubt, and he would rightly be passed by as a time-waster who should attempt to re-open the question, no reproach can attach to the scholar who, unconvinced by De Rougé, should try to find another and better solution of the problem, as some are actually doing. Mr. Taylor overstates the desirableness of acquiescing in the best solution hitherto discovered; the right to doubt an inference not yet made certain is a precious and indefeasible one. It would be highly gratifying to regard the derivation of Phoenician from Egyptian as not less certain than that of English from Phoenician, since then we should have followed up the history to its very beginning; for the character of the Egyptian as a wholly original mode of writing, carrying on its face the evidence of its steps of development from the initial stage, is beyond dispute. Considering that Mr. Taylor holds the hieroglyphics to be the antecedent phase of Phoenician letters, we wish that he had made his exposition of the system somewhat fuller, and especially that he had told in more detail how he regards the alphabetic value of certain of the hieroglyphs as having been arrived at: the point is by no means so clear as were to be wished.

It would take far too much space to go through the book and notice all the points of special interest in it; but attention may be called to a few. Mr. Taylor has a new and well-supported theory as to the Mediterranean alphabet from which the Germanic runes were taken: he holds it to have been the Greek of the Euxine colonies and Thrace, transmitted in peaceful intercourse along the commercial route of the Dnieper, some centuries before the Christian era. His discussion of the Ogham cryptograms is less satisfactory. The Glagolitic (an early Slavonic) alphabet receives from him a suggested explanation which has met with general favor. The earliest Semitic monuments — the sarcophagus of Sidon, the Moabite stele, the recently discovered Siloam inscription — are fully treated, the last being given in facsimile. Some of the most original parts of the author's work lie in the discussion of the South Semitic alphabets and their derivatives. It is to them that he traces the immense group of the alphabets of India by a theory which wears a more plausible and acceptable aspect than any other yet suggested; it must, of course, stand the test of time, and of examination by other experts, before it can be admitted as final. Even in so old and well-worked departments as the varieties of Semitic and Greek writing and their mutual relations, Mr. Taylor brings to light much that is new and interesting, laying under contribution the most recent finds, and combining them with independence of judgment and sound sense. There is nowhere any effort at brilliancy or show of profundity: sober, earnest work is the keynote of the treatise, which in this respect compares favorably with certain other recent publications, French and German, on the same subject.

In conclusion, we may notice adversely a point or two. The now accepted explanation of Pehlevi, as needing to be read out of its Semitic signs into Iranian words, should not be credited to 'the sagacity of Professor Haug' (ii. 239). That explanation was distinctly offered by the veteran Westergaard, in the preface to his Zendavesta, in 1854, when Haug was fresh from the university; and in the latter's earliest article 'on the Pehlevi language and the Bundepesh,' published in the same year, there is to be found no hint of the doctrine.

It is hardly correct to ascribe the success of right methods in paleography in any measure to Darwinism (ii. 363). That every successive phase of a historical institution is the outgrowth of a preceding phase, and differs little from it, is a truth long coming to clear recognition and fruitful application in every department of historic research, prior to and in complete independence of any doctrine of evolution in the natural world. Only error and confusion have come of the attempts made to connect Darwinism and philologic science. On the other hand, Mr. Taylor appears to make a too mechanical application of the doctrine of historical development in denying altogether the possibility of an element of free invention in alphabetic growth. Man is capable of devising something a little different from, or like and additional to, what he has already won and knows how to use. One who has a language can invent another, regarded by him as an improvement on the former: the thing has happened repeatedly, and is no violation of the law of gradual and unconscious growth of human speech. So, notwithstanding the law of alphabetic development, a man who practises various modes of writing can devise a new one, for cryptographic or tachygraphic purposes, or other. And a community that is receiving and adapting an alphabetic system from another community may, in like manner, well enough add a sign or two of its own device: hence the question whether our X is an out-and-out invention of the Greeks, or a differentiated K, is one of paleographic probabilities, not to be settled in favor of the latter alternative by denying the possibility of the former; and so in other like cases.

The number of interesting questions to which this work furnishes a trustworthy reply is surprising; and, while sparing of notes, it yet gives references sufficient to set upon the right track any one desirous of investigating more fully the matters with which it deals.

THE FOSSIL FLORA OF GREENLAND.

Die fossile flora der polarländer. Von Dr. OSWALD HEER. Vol. vii. Zürich, *Wurster*, 1883. 275 p., 62 pl. 4°.

THIS volume contains, 1°, the flora of the upper cretaceous schists of Patoot; 2°, the tertiary flora of Greenland; 3°, a short memoir on insects' remains found in connection with the plants (cf. SCIENCE, i. 1095); 4°, general remarks on the affinities of the plants in relation to their geological age and the climatic circumstances indicated by their characters; 5°, a memoir by Steenstrup on the geology of the localities where remains of plants and coal-deposits have been found; 6°, the marine fauna, with descriptions of the species of invertebrate animals found especially in connection with the plants of Patoot.

This last locality represents the upper member of the cretaceous of Greenland; the lowest being that of Kome, the middle that of Atane. The flora of Patoot has a predominance of conifers and ferns, no Cycadeae, and few monocotyledons, about one-half of the plants being dicotyledons. The table of distribution, which represents the whole cretaceous flora of Greenland, enumerates 335 species, — 88 for Kome, 177 for Atane, and 118 for Patoot. From the characters of the plants, the schists of Kome are referable to the Neocomian. Atane, whose flora is related to that of the Dakota group of Kansas, represents the Cenomanian, while Patoot is apparently Senonian. Most of its species are related to those of Atane, only a few being identified with eocene species from Sezanne and with some miocene types. The plants of the tertiaries of Greenland have been procured from twenty different localities. Their description is also followed by a table of distribution. Of the 282 species enumerated, 33 are known from the tertiary of North America, 10 of them from the Laramie group. The greater number are identified with species found in the lower miocene of Europe, the Aquitanian group, whose flora is widely represented in most of the states, from Hungary to England and France, and from Italy to North Germany. This tertiary flora of Greenland has been predominant, and has preserved its characters for many thousands of years; for the lower strata, where its remains have been found, are separated from the upper, which have the same kinds of plants, by thousands of feet of basaltic masses the deposits of which have been continuous for long periods of time.

In the general remarks considering the climatic conditions which have governed the vegetation as indicated by the characters of the flora, Heer says, that in 1868, from data derived from the determination of 105 species of plants, he had estimated the mean temperature at 9° C.; but now the tertiary flora of Greenland, known by a larger number of plants of various types, — among them a palm, species of Laurus, Magnolia, Diospyros, Sapindus, Zizyphus, etc., whose analogues are now found in Virginia, the Carolinas, etc., — indicates by its constituents a mean temperature of 10° to 11°.

The few mollusks and star-fishes, mostly found at Patoot, have been determined by the French paleontologist, de Loriol. He considers them to be related to some of those described by Meek from the Fox Hill group. Steenstrup's memoir on the geology of the localities where the plants have been found is precise and detailed. It is illustrated by a number of good sections.

The work is accompanied by a map of the western coast of Greenland between 69° 15′ and 72° 30′ north latitude.

THE CHESAPEAKE OYSTER-BEDS.

Report on the oyster-beds of the James River, Virginia (etc.). Coast-survey report for 1881. Appendix, no. 11. By FRANCIS WINSLOW, U.S.N. Washington, *Government*, 1882. 87 p., 22 pl., 3 maps. 4°.

AMONG the various investigations of the U.S. coast survey since its organization, the bearing of which is not confined to their geodetic, topographic, or hydrographic relations, the present publication is conspicuous.

By direction of the late superintendent Patterson in 1878, an investigation of the oyster-reefs or natural beds of the Chesapeake and vicinity was entered upon by Lieut. Winslow with the coast-survey schooner Palinurus. The intention was to determine the limits of the beds, their hydrographic features, the nature of the natural and artificial changes which they undergo, and the present distribution of living oysters upon them. It was proposed to thoroughly investigate a limited area, subsequent extension of the work to all the Chesapeake beds to be left for future decision. Under the term 'Chesapeake' we include here not only the beds in the waters of the bay specifically so called, but those in the extensions of salt water from the bay into the various inlets, arms, rivers, etc., adjacent to and continuous with it.

Originally the oyster beds or 'rocks,' as they are not inappropriately termed by the fishermen, were patches of suitable ground upon which these bivalves had lived for ages, and, dying, left their shells to be overgrown by successive generations. Matted together by this living cement, the successive layers of dead shells and associated *débris* gradually rose toward the surface, covered with distorted, misshapen bivalves in masses like those of the Floridian 'coon oysters.' These beds were separated pretty sharply from the adjacent muddy bottoms, a differentiation which the vertical increase tended to intensify. Horizontal increase doubtless took place, but very slowly. From an economical stand-point the oysters upon these beds were inferior on account of their inconvenient shape and excessive crowding. Among the various conflicting statements drawn out by investigations into the oyster-industry, one fact seems to be generally admitted by fishermen and by experts; namely, that a moderate amount of dredging over the original 'oyster-rocks' was beneficial. This dredging extended the area of the beds, 1°, by dragging the dead shells and 'cultch' over upon adjacent muddy bottoms, and placing it where new spat could settle and grow; and, 2°, by distributing the living oysters more sparsely over the ground, so that they had a chance to grow into regular and even shape and relatively larger size. It is recognized by dealers, — even when the dredging has been carried on, as at present is the case in the Chesapeake, to a disastrous extent, — that the few remaining oysters which are obtained are of larger size and finer flavor than common.

Since the trade in oysters began, the beds have undergone great changes in area and productiveness, until, at present, in two years, on certain beds, the product has diminished in the ratio of six to one, the market-price has nearly doubled, while the demand is constantly increasing. If it were not for supplies received from other sources, the oyster-eaters of cities about the Chesapeake would have to pay nearly European prices for their favorite shell-fish.

It is true that there are numerous laws on the statute-books of Maryland and Virginia; that police steam-launches and men have been enlisted and a sort of war enacted, in time of peace, by state authorities, — all ostensibly in protection of the oyster-beds. Actually the laws are a dead letter; dredging is boldly carried on in close time before the eyes of the 'oyster police,' without the offenders being molested; and the only occasion for active measures arises when a Virginia dredger trespasses in Maryland waters, or *vice versa*. Gore is then apparently in demand, but, in spite of vehement protestations, turns out almost as scarce as oysters.

It was upon this state of things that Lieut. Winslow entered, when he undertook this work without previous experience, or any knowledge of the biological questions involved, except such as might be gleaned from the valuable little work of Moebius on the North Sea fisheries of Europe. Many of the observations which he was directed to take, are, in the present state of our knowledge, productive of no definite result, though eventually they may prove very useful. Thus, observations of the specific gravity and temperature of the water at the bottom and surface, when the total depth was only a few feet, may be said to be almost absolutely fruitless. It is well known that our common oyster flourishes in water which varies at different seasons from the freezing-point to 80° F., and that similar differences of specific gravity must occur between the extremes of its geographical range. Consequently the differences, in summer, of fractions of degrees of temperature in the water over oyster-beds, are of no consequence whatever. What these changes of temperature may signify, when taken in connection with the act of spawning or the development of the embryo, is quite another question, purely biological, and which can be properly treated only by a biological expert of high rank and long experience.

The result of these superfluous observations and detailed description of each individual bed, even condensed as they are, as far as possible, by the author, is to overload the text with details of no interest, and thus to obscure to the reader the value of the investigation, the really interesting facts, and the merits of the investigator, which are neither few nor small. They will amply repay any one who has patience to wade through the mass of details, and pick out those of present value, of which there are many. Space forbids any attempt to summarize them. A large area of the beds was delineated, and the approximate number of marketable oysters upon them determined. Profiles of the beds were obtained in numerous instances, and the character of the subsoil, or bottom under the beds, determined as were the conditions of sedimentation. Nearly all the beds examined are described in detail. Valuable biological data were obtained through the efforts of Dr. W. K. Brooks and Mr. H. J. Rice, most of which have been already made public in other ways. Much information on the general topic was obtained by questioning the fishermen, whose replies, though biassed by self-interest, may be set off against one another, and a residuum of useful facts obtained.

FIG. 1.—LOWER SIDE OF TILE EXPOSED JULY 9–AUG. 2. (TWO-THIRDS NATURAL SIZE.)

To our judgment, apart from the survey and delimitation of many oyster-beds, the most important results of this investigation are, 1°, the determination of the approximate quantity of oysters to the square yard over a great portion of the beds; and, 2°, the data in regard to the rapidity of growth of the young mollusks as indicated by the tile-collectors, and the proportion of mortality among them from causes not yet fully explained. The determination of the small mollusk Astyris, as an enemy of the infant oyster, though not conclusive, is of interest, and, if finally confirmed, important.

The determination of the number of oysters, though as a matter of course approximate only, is important as giving a point of comparison by which future decrease may be measured by repeating the investigation in similar fashion.

There is no doubt that in a comparatively limited time the majority of the Chesapeake beds will be practically destroyed, so far as producing oysters for a market is concerned. Some forty thousand people will have to seek employment in a different field. Probably, under the circumstances, this is the best thing that could happen; for it is doubtful if any less drastic medicine would have the slightest effect on the population residing in the vicinity of the oyster-beds, who, in the face of all the facts, have persisted in setting themselves like flint against any modification or check on their career of destruction. The present observations on the growth and surviving percentage of young oysters on the tile-collectors would have been much fuller and more valuable, had not the oystermen cut the buoys adrift, stolen the thermometers and lines, and destroyed such collectors as they could reach unseen, with the stupid notion that some reservation of beds, or limitation of fishing, was to result from the investigation. Twenty-four bundles of tiles were set and buoyed between July 1 and 14, and by Aug. 1 all but one were

FIG. 2.—LOWER SIDE OF TILE EXPOSED JULY 9–AUG. 23. (TWO-THIRDS NATURAL SIZE.)

removed or destroyed. Fig. 1 represents a portion of one of these tiles, which was placed in position July 9. On July 19, when first examined, there were a few oysters upon it, but so small that a microscope was necessary to reçognize them. On Aug. 2 it was again examined, and the tile of which a portion is figured was removed from the bundle. There were then from 26 to 348 young oysters on a tile; the total number upon the whole bundle was 1,506.

The third examination was made Aug. 23, when it was found the oysters had increased very much in size and numbers. On the tiles remaining, there were 1,334 oysters. A tile of which a portion is represented in fig. 2 was then removed. On Oct. 10 the bundle was again examined. The oysters had decreased fifty-five per cent in numbers; but two-thirds of them were now over three-quarters of an inch, and two specimens over two inches long, though the shells were still extremely delicate. Part of one of these tiles is represented by fig. 3.

FIG. 3.—UPPER SIDE OF TILE EXPOSED JULY 9–OCT. 10. (TWO-THIRDS NATURAL SIZE.)

It was thus determined, that in 1879 the attachment of the young oysters began about the middle of July, and continued about a month, as after Aug. 20 there were no signs of fresh attachments; that fully fifty per cent died from natural causes within six weeks, no traces of predacious mollusks being noticed on the dead shells, though the evidence on this point is imperfect; that, the attachments being far more profuse on the concave under side of the tiles, the spat just previously must be on or near the bottom, and must rise to attach themselves; lastly, that the rate of growth is much more rapid than had previously been supposed, and may reach two inches in length in three months. Numerous other points of interest may be gleaned from the report, for which we have not space. Enough has been said, however, to show the value of Lieut. Winslow's work, the intelligence and assiduity with which it was carried on, and the wide field which awaits further investigation.

THE PEBBLES OF SCHLESWIG-HOLSTEIN.

Die sedimentär-geschiebe des provinz Schleswig-Holstein. Von Dr. C. GOTTSCHE. Als manuscript gedruckt. Yokohama, *Lévy & Salabelle*, 1883. 6+66 p., 2 maps. 8°.

THIS treatise by Dr. Gottsche, who is at present in Yedo, was an accepted thesis for admission to the position of private teacher at the Kiel university in 1880, printed privately in German at Yokohama in 1883, and seems to be a very painstaking and pretty thorough description of the pebbles, whether of rocks, minerals, or fossils (seventy-six kinds in all), found in four quaternary sedimentary beds at Kiel, with especial reference to the identification of their source, and is accompanied by two maps, — one showing with straight lines thirty directions in which such pebbles of the lowest bed appear to have been transported, and the other giving with similar lines the dissemination of three particular kinds of rock in the same Baltic region. Many of the lines are only a couple of hundred miles long, but some are six hundred or more. The author himself points out that the pebbles have not by any means necessarily been carried along those straight lines; and the place of origin may not necessarily have been exactly at the points where identical rocks are only found at present. Nevertheless the lines show that the transfer has in general been from the north-east, north, or north-west, and never from the westward or southward of Kiel. Of course, there need have been no more than two directions of movement, south-westerly and south-easterly; for the pebbles carried a part of their course in one direction may have been carried the rest of the way in the other, and so produced any resultant direction between the two; or materials carried by floating ice may have come in a far more crooked course (and the places of origin are all on the shores of the Baltic, or on streams flowing into it). The lower sedimentary bed, with only a couple of exceptions, contains, so far as now known, every kind of pebble found in the upper ones, so that no inferences can yet be drawn as to changes with time in the direction of transport. The main result would seem then to be, that the Kiel sediments have all come from more northern parts of the Baltic basin, and might have been carried chiefly by floating ice, without a climate so very different from the present one.

The author is highly to be commended for his liberality in printing his pamphlet of sixty-six large octavo pages at his own expense, and that, too, in a country where good European printing is particularly troublesome. The two maps might, perhaps, have been advantageously combined in one, if one of the two sets of lines had been of a different character (say, dotted or broken) or of another color; for the very object of cartographic representation is to show at one view as much as can possibly be distinguished clearly of any given subject, — to assemble for convenient comparison on one sheet as many as may be of the scattered facts of nature bearing upon any given point.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Spectra of comets observed in 1881. — P. Tacchini discusses the varying appearances presented by the spectra of the comets *b* and *c* 1881, and accompanies his remarks with an extensive series of nearly forty lithographed drawings illustrating the changes which occurred. These changes, for the most part, consist merely in variations of the brightness and diffusion of the observed bands, and not in any alterations of position. He gives also a single figure of the spectrum of Encke's comet, observed the same year, and a set of twenty drawings of the comets (*b* and *c*) themselves. The paper, with its accompanying plates, constitutes an important collection of observed data; and some slight discrepancies between these representations and those of other observers raise interesting questions. — (*Mem. soc. spettr. ital.*) C. A. Y. [263

Uranus. — Within the last few months, considerable attention has been paid to this planet, and a number of series of observations upon it have been published. Safarik (*Astr. nachr.*, 2505), Meyer (*Astr. nachr.*, 2524), and Schiaparelli (*Astr. nachr.*, 2526), all present the results of their measures made for the purpose of determining its diameter and ellipticity. The observations of Schiaparelli are the most numerous and complete. He finds for the equatorial diameter of the planet 3″.911, and, for the polar, 3″.555 (both reduced to the mean distance 19.1826). This gives the ellipticity of the planet $\frac{1}{11}$, nearly the same as that of Saturn. He also reports the existence, upon the planet's disk, of spots and changes of color, too faint, however, to admit of delineation by means of a telescope of only eight inches aperture. In fact, to have seen them at all with such an instrument is a most remarkable evidence of the wonderful clearness of the Italian sky. The writer of this notice also made a series of observations upon the same object, in May and June, with the twenty-three inch equatorial of the Princeton observatory. Markings upon the planet's disk were unmistakably visible as belts resembling those of Jupiter and Saturn. The equatorial diameter determined by the writer's measures is 4″.280, and the polar, 3″.974, giving an ellipticity of $\frac{1}{14}$. Mädler, in 1843, obtained 4″.304 and 3″.869 for the two diameters, and an ellipticity of $\frac{1}{10}$. There can no longer be any doubt that the planet has a rapid rotation nearly in the plane of the satellite-orbits. — C. A. Y. [264

MATHEMATICS.

Perimeter of the ellipse. — Mr. Thomas Muir, referring to a recent article by M. Mansion, infers that the following formula, which he has known for some time, for calculating approximately the perimeter of an ellipse, has not yet been published. Denoting as usual by a and b the semi-axes of the ellipse, the expression for the perimeter is

$$2\pi \sqrt[\frac{3}{2}]{\frac{a^{\frac{3}{2}} + b^{\frac{3}{2}}}{2}};$$

or, *the perimeter of an ellipse is approximately equal to the perimeter of a circle whose radius is the semi-cubic mean between the semi-axes of the ellipse.* — (*Mess. math.*, xii. no. 10.) T. C. [265

Calculus of variations. — The general problem of the calculus of variations is to find the variation of an n-tuple integral of a function of n independent variables, and of depending also upon a number of arbitrary functions of these variables, together with the differential coefficients of the functions. M. Picart in his paper, which he entitles *Theorie nouvelle du calcul des variations*, confines his attention to a triple integral containing only one arbitrary function, and solves several of the more fundamental problems connected with the determination under various conditions of the variation of the integral. In particular, he shows how the problem of relative maxima or minima can be conducted to that of absolute maxima or minima. — (*Nouv. ann. math.*, Feb.) T. C. [266

PHYSICS.

(*Photography.*)

Photographing Reichenbach's flames. — The question of the actual existence of these flames, surrounding the poles of powerful magnets, has again been brought up for discussion in scientific circles. Numerous persons have claimed to be able to see them, and some even to be able to distinguish between the poles and the color of the flames. Reichenbach himself attempted to photograph them by the daguerrotype process, but was apparently dissatisfied with the results he obtained. Mr. William Brooks has taken the matter up, and thinks he has obtained actual impressions of the flames, by means of photography, on sensitive dry plates prepared especially for the purpose. In total darkness a perforated blackened card was placed one-eighth of an inch above the poles of a permanent horseshoe-magnet, and a sensitive plate placed an eighth of an inch above the card. With five minutes exposure he obtained a result; and this was repeated many times, the most remarkable thing being, that sometimes he obtained a positive and sometimes a negative image, under precisely the same conditions. Another curious effect obtained was, that some printed matter, which was under the wash of Indian ink used to blacken the card, was perfectly readable when the plate was developed. This latter result, however, was obtained on only one occasion. He also succeeded in obtaining prints through a glass plate on which were painted figures in black varnish. This was contrary to the experience of Reichenbach, who considered that the rays were not transmitted through glass. — W. H. P. [267

Hydrokinone. — Of this new developer, first introduced by Capt. Abney, Mr. Charles Ehrmann says, "The best results I have obtained with ten grains of hydrokinone to eight ounces of water, and caustic ammonia (1 to 7) added gradually as the development progressed. The negatives are of a non-actinic color, similar in tone to one slightly intensified with uranium and prussiate of potash; therefore the development need not be carried on very far, thus preserving all finer modulations. An injudicious amount of alkali will produce green fog." — (*Phot. times*, July.)

Of this same developer, Mr. Edwin Banks claims that it is much more powerful than pyro, and that it will bring out a fully developed picture with at least half the exposure that is necessary when pyro is employed. At first sight this seems strange, when it is observed how much more powerfully the latter absorbs oxygen; but the explanation probably lies in the fact that hydrokinone is more gradual in its action, and has a greater selective power, than pyro. With a collodio-bromide film, for instance, which is not so much protected from chemical action as one of gelatine, pyrogallic acts with such energy when mixed with an alkali, that the whole film is reduced immediately, and no image, or only a faint one enveloped in fog, appears: hence a powerful restrainer must be used to keep this action within bounds. A soluble bromide, which is the salt commonly used, has this effect, but, unfortunately, at the same time partially undoes the work which the light has done, rendering it necessary to give a longer exposure. But with hydrokinone no restrainer is necessary, unless a great error in exposure has been made. It does its work rapidly and cleanly, in this respect resembling ferrous oxalate. It does not discolor during development so much as pyro, and consequently does not stain the film so much, whilst full printing vigor is very easily obtained without having to resort to intensification. The color and general appearance of the negative are more like those of a wet plate, since the shadows remain quite clear, and free from fog. It seems almost impossible to fog a plate with it. One grain of hydrokinone to the ounce is strong enough for most purposes. With some samples of hard gelatine it is advisable to use two; but with most kinds and with collodion, one grain is sufficient. Two or three drops of a saturated solution of washing-soda to the ounce of the hydrokinone solution rapidly develops the image, and the addition of a few drops more to complete development is all that is needed. A soluble bromide acts very powerfully as a retarder and restrainer. With a mere trace added, development is very much slower. — (*Brit. journ. phot.*, July 6.) W. H. P. [268

ENGINEERING.

Sources of error in spirit-levelling. — Precise levelling in this country has been done by the U. S. lake survey, which has determined the elevation of all the great lakes with a probable error of less than one foot; by the coast and geodetic survey, which is carrying a line of levels across the continent from Chesapeake Bay to San Francisco; and by the Mississippi River commission, which has a line from the Gulf as far north as central Iowa, to be connected with Lake Michigan, and thence with the sea-level at New York. Mr. J. B. Johnson has been connected with some nine hundred miles of this work, and discusses the sources of error. He first classifies errors into compensating and cumulative. Then he treats them as, 1°, errors of observation, in the instrument or in the rod; 2°, errors from instrumental adjustment; 3°, errors from unstable supports; 4°, atmospheric errors, from wind, from tremulousness of the air caused by difference of temperature, and from variable refraction. He concludes, that, with good instruments and proper care, thirty miles of line should be duplicated a month with one Y-level and a target-rod, and all discrepancies brought within five-hundredths of a foot into the square root of the distance in miles; or with the U. S. precise levels and speaking-rods, reading three horizontal wires, one instrument should bring the discrepancies within two-hundredths of a foot into the square root of the distance in miles.

The Mississippi River levels have been well within this limit. — (*Journn. assoc. eng. soc.*, March.) C. E. G. [269

GEOLOGY.

Lithology.

Gold in limestone. — According to Prof. C. A. Schaeffer, gold occurs in a ferruginous cretaceous limestone from Williamson county, Tex. This rock lies near the surface, and fifty-two samples procured *in situ* by him averaged $15.20. Twenty contained no gold, while thirty-two assayed from $1.00 up to $231.50 per ton. He regards the gold as having originally existed in the limestone in pyrite, which has since been removed and the gold locally concentrated. — (*Trans. Amer. inst. min. eng., Boston meeting.*) M. E. W. [270

The Ottendorf basalt. — Rudolf Scharizer discusses the occurrence, microscopic and chemical composition, of this Silesian (Austria) basalt, its alteration, and contact phenomena with the grauwake-sandstone. The paper is quite full of chemical analyses. Olivine, somewhat serpentinized, is the predominating mineral, enclosed in a ground-mass of augite, magnetite, biotite, anorthite, nepheline, etc. The chemical analysis indicates that the rock is closely allied to the peridotites, if it does not belong to them. — (*Jahrb. geol. reich.*, xxxii. 471.)

The same journal contains an extended paper by Messrs. Teller and John, on the geological and lithological characters of the dioritic rocks of Klausen in the South Tyrol, a series of very diverse rocks including gabbros or norites. — (*Ibid.*, 589.) M. E. W. [271

METEOROLOGY.

The rain-storm in Ontario on July 10. — The Canadian meteorological service has made a special investigation of this storm, which caused such unusual destruction in the vicinity of London, Ontario. Observations from over one hundred observers were received and studied. The isobaric curves show only such undulations as generally accompany showers and thunder-storms in the summer season; and there was nothing in the maps to warrant the expectation of any storm, beyond the 'local showers' which were officially predicted, and which occurred in other parts of Ontario. The fluctuations in barometric pressure were hardly appreciable, and there was but little wind. Indeed, the only peculiarity of the storm was the unaccountable and unexpected precipitation, which exceeded four inches where the maximum occurred. This amount was recorded in an elliptical area of country, extending in a direction about north-west and south-east, and covering a territory of about twenty by fifty miles. The devastation at London was due to the fact that the two branches of the Thames River, which there unite, approach from nearly contrary directions, the river flowing away nearly at right angles to the branches. The question is therefore raised, whether it would not be advisable to divert one of the branches, that it may meet the other at an acute angle, and thus lessen the probability of a repetition of the catastrophe. The need of an increased number of rainfall observers is pointed out, that means may be afforded for extensive study into the little-known subject of the course and causes of local rains. — (*Can. weath. rev.*, July.) W. U. [272

GEOGRAPHY.

(*Alpina.*)

Ascent of Indrapura, Sumatra. — An account is recently published of the persevering and first successful attempt of Veth and Van Hasselt, several years ago (1877), to ascend this highest of the Sumatran volcanoes. They had to choose a way through the dense forest of the lower slopes, and over the sharp, loose rocks nearer the summit; and sudden heavy rains caused them much delay, so that eight days were spent in reaching the highest point, although the rim of the crater was gained a day earlier. Elephant-tracks were not found above 1,500 met., rhinoceros-tracks not above 2,600; but wild goats had been on the very summit. Above 2,500 met., large trees were absent; and above 3,000 only a few plants had found place to grow on the naked volcanic rocks. The barometer read 482.4 mm., and the thermometer, 8° C., corresponding to a height of about 3,700 metres. The surrounding country had the appearance of a uniform forest wilderness, occasionally broken by volcanic peaks and ranges, and showing a cultivated region by its lighter color in the distance near the coast. A deep crater lay within the sharp, ragged walls; several streams ran down to a pool at the bottom, a thousand metres below the rim, whence sulphurous vapors and clouds of steam rose into the great caldron. The volcano was in eruption in 1842, when described by Junghuhn. The descent was accomplished without serious difficulties. — (*Deutsche geogr. blätter*, vi. 1883, 130.) W. M. D. [273

(*South America.*)

Bolivian rivers. — On the occasion of Dr. E. R. Heath's account of his exploration of the Beni and other rivers flowing from the Andes north-eastward to the Amazon system, Mr. C. R. Markham, secretary of the Royal geographical society, gave a general description of the region, part of which he had visited in 1853. The mountains in which the rivers rise are part of the eastern range of the Andes, rising into great peaks like Illimani and Illampu, to a height exceeding 21,000 feet, with fossiliferous silurian rocks up to their summits. To the west is the great interior plateau of the Titicaca basin; to the east, the rivers descend, bearing gold gravels to the great plains, covered with unbroken forest. This eastern region has been very little explored; and the india-rubber and cinchona bark gathered about the upper streams are carried westward over the mountains to the Pacific ports, rather than down the rivers to the Amazon and the Atlantic. Markham sketches the history of exploration here from the time of the Inca expedition in the fifteenth century to the expeditions of Maldonado down the Amarumayu in 1866, and Heath down the Beni in 1880; these being the only travellers who have followed the rivers down to their junction. Dr. Heath mapped the whole course of the Beni with great care, taking astronomical observations, and measuring the width, depth, and velocity of the water. On reaching the Madeira, as the river is called below the junction of the Beni and Mamoré, he ascended the latter to Exaltacion, and then followed Yacuma, and crossed the country beyond its source to Reyes again on the Beni, where his return was celebrated by a public reception and a special mass. The people here were greatly excited over his report on the number of rubber-trees in the country he had passed through; and from 185 men engaged in collecting 104,000 pounds of rubber in 1880, the number increased to 644 in four months, and must now reach one or two thousand. From Reyes he ascended the Beni to La Paz. His report is very brief, and contains little beyond an itinerary; rapids and rocks are occasionally mentioned, and a few lakes were passed, but there is no material given toward a physical description of the country.—(*Proc. roy. geogr. soc.*, v. 1883, 313, map. [Dr. Heath's paper is also given in the *Bull. Amer. geogr. soc.*, 1882, no. 3.]) W. M. D. [274

BOTANY.

American smuts. — Farlow, in some notes on Ustilagineae, gives the first account of American Entylomata, his list including eight species, one only of which appears under another genus in earlier lists. Four of these are, for the present, described as new, though two may prove to be identical with species growing on the same host genera, in other countries. One is doubtfully considered to be a form of a European species; the balance occur also in the old world. Two American species of Cornu's new genus Doassansia — D. Farlowii Cornu and D. epilobii Farlow — are recorded; the former in the ovaries of Potamogeton, the latter in leaves of Epilobium. — (*Bot. gazette*, Aug.) W. T. [275

Fertilization of Leptospermum. — In a fourth paper on the indigenous plants of Sydney, E. Haviland considers the structure of the reproductive organs of this genus and its mode of fertilization. Cross-fertilization is regarded as probably the rule, brought about, 1°, by the difference in the times of maturing of the anthers and stigma; and, 2°, by changes in their relative positions. — (*Linn. soc. N. S. Wales; meeting* June 27.) [276

ZOÖLOGY.

Mollusks.

Astarte triquetra Conrad. — This minute and peculiar shell, recently rediscovered by Mr. Hemphill in Florida, but described by Conrad more than thirty years ago, proves to be a new form, Callicistronia, perhaps related to Tivela, with a small sinus in the pallial line, two large cardinal teeth in one valve, and one in the other. It is viviparous. More than fifty young ones were found in a single specimen, recalling the habit of Psephis. — W. H. D. [277

Anatomy of Urocyclus. — Dr. Paul Fischer has examined the soft parts of Urocyclus longicauda F. from Madagascar. The digestive tract resembles that of Parmacella and Limax. There is a large mucus-vesicle analogous to the vestibular prostate in Parmacella, Tennentia, and Ariophanta. Otherwise the reproductive organs resemble those of Helicarion, and a slug described in detail by Keferstein under the name of Parmarion in 1866, and which proves to be a true Urocyclus. This genus is African, while Parmarion is of Asiatic and East-Indian distribution. Urocyclus has an oxygnathous arcuate jaw, a rhachidian, thirty-nine lateral and thirteen uncinal teeth in one hundred and twenty-five rows. Dendrolimax of Heynemann appears to differ from Urocyclus merely in the absence of the mucus-vesicle, and will fall into synonymy. — (*Journ. de conchyl.*, xxii. 4.) W. H. D. [278

VERTEBRATES.

Reptiles.

Nerve-endings in the caudal skin of tadpoles. — The epidermis of the skin of tadpoles has two layers of cells. In the deeper cells, on the tail, appear peculiar bodies, first seen by Eberth (*Arch. mikros. anat.*, ii. 90) and Leydig (*Fortschr. naturf. ges. Halle*, 1879, taf. ix. fig. 32). The latter compared the bodies in question with the nettles of lasso-cells, giving to the cells containing the bodies the strange name of 'byssuszellen.' Pfitzner (*Morph. jahrb.* vii. 727) showed that these bodies are united with nerve-filaments, every one of the cells being so supplied. The nerves of the skin had been studied by Eberth (*l.c.*) and Hensen (*Virchow's arch.*, xxxi. 51 ; *Arch. mikros. anat.*, iv., 11). Canini and Gaule have studied the subject afresh, rectifying and supplementing the previous writers. The bodies in the basal epidermal cells appear as thick rods curved into bizarre and varying shapes. Each is connected with a nerve-filament (sometimes, but not always, as maintained by Pfitzner, two filaments run to one cell). The filaments descend through the gelatinous corium (cutis), to unite just below with a thick nucleated network of threads, which, from their reactions, are regarded as nervous tissue, and distinct from the cojacent plexus of connective-tissue corpuscles. This network, again, is connected with a deeper-lying, coarser plexus, corresponding to Ranvier's *plexus fondamentale*. These peculiar end-organs are not found, except in the tail: they are probably sensory, but Gaule hesitates to deny Leydig's interpretation. — (*Arch. anat. physiol., physiol. abth.*, 1883, 149.) C. S. M. [279

Birds.

Xenicidae, a new family. — On dissection of a specimen of Xenicus longipes and one of Acanthositta chloris, Mr. Forbes found the syrinx to be strictly mesomyodian. On account of this, the long tenth primary and the non-bilaminate tarsus, the birds are removed from the vicinity of Sitta as a family, Xenicidae, of non-oscinine Passeres in the vicinity of the Pittidae. — (*Proc. zoöl. soc. Lond.*, 1882, 569.) J. A. J. [280

Anatomy of the todies. — After a careful examination of the structure of this group, Mr. Forbes concludes that the todies are an isolated form of anomalogonatous birds, with no clear affinity to any living group. He therefore proposes to raise them to the group Todiformes, equivalent to the Passeri, or Piciformes.—(*Proc. zoöl. soc. Lond.*, 1882, 443.) J. A. J. [281

Illinois birds. — Nehrling continues his annotated list of Illinois birds in the full and learned manner so distinctive of German work. The present instalment contains thirty-nine species, from the bobolink to the great horned owl inclusive.—(*Journ. f. ornith.*, xxxi. 84.) J. A. J. [282

Mammals.

The os intermedium of the foot. — Dr. Karl Bardeleben gives a *résumé* of his observations upon the bones of the foot. A well-developed intermedium is present in many species of marsupials, but not in all. Its presence in a given species does not always imply its existence in closely allied species. For example: it occurs in Chironectes variegatus, but not in C. palmatus. The bone varies in size from one centimetre to a fraction of a millimetre. It does not exist in marsupials of which the hand has undergone regressive alterations, e.g., Halmaturus Bennetti, H. giganteus, etc. The separation of an intermedium is indicated in the monotremes, many edentates, as well as in the genera Elephas, Hippopotamus, and Tapirus, by a fissure, more or less deep, in the astragalus. Dr. Bardeleben suggests the name 'os trigonum' for the bone in question. — (*Zool. anz.*, no. 139.) F. W. T. [283

Odontoblasts and dentine. — R. R. Andrews has studied the development of teeth in pig embryos, and publishes the remarkable conclusion that the odontoblasts entirely disappear, forming the matrix of the dentine, and have nothing to do with the dentinal fibrils, which he claims arise from deeper layers, probably from nerve-fibres. (We are not prepared to agree with these views.) — (*N. E. journal of dentistry*, ii. 193.) C. S. M. [284

(*Man.*)

Measurements of the depth of sleep. — Two of Vierordt's pupils, Mönninghoff and Piesbergen, have made the depth of sleep the subject of an investigation. They worked upon the principle that the depth of sleep is proportional to the strength of the sensory stimulus necessary to awaken the sleeper, that is, to call forth some decisive sign of awakened consciousness. As a sensory stimulus they made use of the auditory sensation produced by dropping a lead ball from a given height. The strength of the stimulus was reckoned, in accordance with some recent investigations of Vierordt, as increasing, not directly as the height, but as the 0.59 power of the height. For a perfectly healthy man, the curve which they give shows that for the first hour the slumber is very light; after 1 hour and 15 minutes, the depth of sleep increases rapidly, and reaches its maximum point at 1 hour and 45 minutes; the curve then falls quickly to about 2 hours 15 minutes, and afterwards more gradually. At about 4 hours 30 minutes, there is a second small rise which reaches its maximum at 5 hours 30 minutes, after which the curve again gradually approaches the base line until the time of awakening. Experiments made upon persons not perfectly healthy, or after having made some exertion, gave curves of a different form. — (*Zeitsch. f. biol.*, xix. 114.) W. H. H. [285

ANTHROPOLOGY.

Notes on Mitla. — In July, 1881, Mr. Louis H. Aymé visited the ruins of Mitla, which lie in Oaxaca directly south of Vera Cruz. Mitla is not so grand, so magnificent, as Uxmal; but it has a beauty of its own, as it nestles quietly at the foot of the mighty mountains, the ruins of grim 'Fortin' standing sharp against the evening sky; and, as the sun sinks, one might fancy he heard the weird chant of the priests, the lament of the mourners for the dead who rest in Lyobaa, the Centre of Rest. Appended to M. Aymé's itinerary is a translation by Mr. S. Salisbury, jun., of the description of Mitla, by Francisco de Burgoa, written in 1674. Then follows a report of the various buildings constituting the north and south groups, which for detailed statement and brevity is a model archeological document. Mr. Aymé is able to correct some of the errors of his predecessors. It is gratifying to quote the following: "The buildings are carefully looked after by the government, and have an intelligent guardian in the person of Don Felix Juero." Comparing the present account with Burgoa's, Mr. Aymé concludes that in 1644 the ruins were practically as they are to-day. — (*Proc. Amer. antiq. soc.*, ii. 82.) J. W. P. [286

The Olmecas and the Tultecas. — Mr. Philipp J. J. Valentini gives some very cogent reasons for thinking that the sanguine hopes of the decipherers of American hieroglyphics will never meet the realization of those who unravelled the sacred languages of Egypt and Mesopotamia. Except for the wonderful similarity which early Mexican civilization bears to that of the ancient nations of the eastern hemisphere, only a fraction of the workers could have been induced to undertake the labor. The right way to treat these matters is to moderate our expectations. With such motive, the author then endeavors to fix the main epochs, and to inquire who were the Olmecas and the Tultecas. The former search results in fixing the dates of all we know concerning Mexican history between the years 232 and 1521 of the Christian era. Mexican history begins with the record of a race of giants, the Quinamé, or Quinametin, who are claimed to have been a people of Maya origin, found by the Nahuatls on the Atoyac River, when they were migrating southward. When the name of the Olmecas appears in the early Mexican records of the Nahoas, we must not hesitate to recognize in them that people east of Anahuac who spread along the Atlantic slopes and south through Yucatan, Tabasco, and the whole of Guatemala, and whom we designate to-day by the collective name of Maya. No nation, empire, or language of Tultecas ever existed. The Tultec exodus is shown to refer to the migrations of the Colhuas who shared with the Mexicans the rule of the uplands. Their journey to Culiacan was not from the Pueblos, but from the borders of the Gulf of Mexico. — (*Proc. Amer. antiq. soc.*, ii. 193–230.) J. W. P. [287

North-eastern Borneo and the Sulu Islands. — Although north-eastern Borneo is close to the Sulu group, there is a great difference in the people. The Sulus are Malays, with a considerable infusion of Arab and Chinese blood. The Bajaws, or sea-gypsies, lead a nomadic life in their boats, each boat containing an entire household. The Sulus are divided into coast Sulus and the Orang Gumber, living among the hills, and they are much above the Bajaws in character. The latter are stronger in physique, but timid and treacherous. On the coast-line of Borneo is an extraordinary mixture. At Melapi, sixty miles up the Kina Batangan, are Sundyaks, Malays, Javanese, Sulus, Bajaws, Bugis, Chinese, Arabs, Klings, and many others; while of the Buludupies, the indigenous inhabitants, there are hardly any of pure blood left. These indigenes are an interesting people, their ancestry showing distinct signs of a Caucasian type. The rest of north-eastern Borneo is inhabited by tribes of the race styled Eriaans, Dusuns, or Sundyaks, who are of Dyak blood, with perhaps an infusion of Chinese. The Chinese language, dress, etc., are entirely lost, however. Slavery of a clan or feudal type is universal, and the Mohammedan religion prevails. The Sundyaks are divided into many tribes, some of which are gaining in power. *Cf.* i. 552. — (*Proc. roy. geogr. soc.*, v. 90.) J. W. P. [288

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

PUBLIC AND PRIVATE INSTITUTIONS.

Dudley observatory, Albany, N.Y.

Comet b, 1883 (Brooks). — By means of observations secured at the Dudley observatory on Sept. 5, 9, and 18, I derived on the 19th the following parabolic elements, marked I. The remarkable similarity of these elements to those given by Schulhof and Bossert for the Pons comet of 1812 pointed unmistakably to their identity. The elliptic elements of the Pons comet (here marked II.) are transcribed from the memoir of Schulhof and Bossert (p. 150), except that they are reduced to the mean ecliptic and equinox of 1883.0, and a value of T, derived from observations of the present apparition, is substituted.

I.		II.	
T = 1884, Jan., 25.788 (G.M.T.).		T = 1884, Jan., 25.696 (G.M.T.).	
Node	254° 13′.6	Node	254° 8′.8
Node to perihelion .	199 14 .4	Node to perihelion .	199 12 .9
Inclination	74 47 .1	Inclination	74 63 .3
Log. q.	9.87944	Log. q.	9.88930
		Eccentricity . . .	0.95527

The value of T in II. was determined by approximation from the observation of Sept. 5. The remaining observations do not indicate any important change in its value. The following ephemeris results from elements II. The geocentric positions are referred to the mean equinox of 1883.0.

Greenwich, 12 hours.	a h.	m.	s.	δ °	′	Log. Δ	Light.
Sept. 2	16	36	37	65	03.0	0.3725	.03
" 6		32	19	64	13.9	0.3648	.03
" 10		29	06	63	23.0	0.3569	.04
" 14		26	53	62	31.1	0.3487	.04
" 18		25	37	61	38.3	0.3400	.04
" 22		25	15	60	45.2	0.3310	.05
" 26		25	45	59	52.4	0.3215	.05
" 30		27	01	58	59.6	0.3115	.06
Oct. 4		29	06	58	07.5	0.3009	.06
" 8		31	57	57	16.5	0.2897	.07
" 12		35	32	56	26.5	0.2779	.08
" 16		39	52	55	37.6	0.2653	.08
" 20		44	56	54	49.9	0.2518	.09
" 24		50	47	54	03.3	0.2377	.10
" 28		57	25	53	17.8	0.2226	.12
Nov. 1	17	04	53	52	33.3	0.2065	.14
" 5		13	15	51	49.6	0.1893	.16
" 9		22	34	51	06.0	0.1708	.19
" 13		32	56	50	22.4	0.1512	.22
" 17		44	26	49	37.0	0.1302	.26
" 21		57	14	48	49.4	0.1077	.32
" 25	18	11	27	47	57.1	0.0836	.38
" 29		27	16	46	58.1	0.0580	.46
Dec. 3		44	50	45	43.2	0.0300	.57

In the light scale, .19 corresponds to that of discovery in 1812, and 1.00 to the time when the comet was reported as visible to the naked eye in the apparition of 1812. The places of the above ephemeris represent the observations already made within about 30″ in each co-ordinate, and with a very uniform minus value of 'c-o' throughout. This seems to be the fault of the elliptic elements. Any considerable change in the time of perihelion passage diminishes the discrepancy in one co-ordinate at the expense of the other.

It is remarkable that the present comet should have been picked up when its light ratio was six times as small as it was at discovery, in 1812. It was then regarded as a faint object. Were it not for the overwhelming testimony from other sources, one might doubt, on the ground of brightness, the identity between the present comet and that of 1812. The following rough ephemeris may be of interest: —

	a	δ	Light.		a	δ	Light.
1883.	h. m.	°		1884.	h. m.	°	
Dec. 3 .	18 45	− 45.7	.6	Feb. 1 .	0 34	− 28.3	2.3
" 13 .	19 37	− 41.7	1.0	" 11 .	1 02	− 37.2	1.5
" 23 .	20 41	+ 33.9	1.8	" 21 .	1 23	− 43.7	1.0
1884.							
Jan. 2 .	21 53	+ 22.1	3.5	Mar. 2 .	1 43	− 48.5	.6
" 12 .	23 01	+ 2.5	4.1	" 12 .	2 02	− 53.0	.4
" 22 .	23 53	− 15.2	3.0	" 22 .	2 26	− 56.2	.4

The identity of the Pons comet of 1812 with comet *b*, 1883, was announced in an 'associated press' despatch from the Dudley observatory on the evening of Sept. 19. LEWIS BOSS.

Sept. 21, 1883.

Massachusetts institute of technology, Boston, Mass.

Extension of the course in biology. — Advantage is at once to be taken of the extension in the building accommodations, and the improvement in the financial resources of the institute, to greatly enlarge the space heretofore given to biological work, and to increase the instructing staff of this department of the school.

The removal of the physical laboratory to the new building on Clarendon Street affords the long-desired opportunity for the expansion of the biological laboratory, heretofore confined to a single small room in the low brick annex. The large north room (90 x 28 ft.) on the first floor of the main institute building (the Rogers Building), with its admirable light and its many facilities, will be devoted to the purposes of the natural-history course, and will be fitted up with appropriate apparatus and instruments. Within a short time, it is also anticipated that a room in the basement (being one of those now occupied by the chemical or by the metallurgical department) will be available for use in dissections and in the coarser work of a biological laboratory.

Dr. W. T. Sedgwick, a graduate of the Sheffield scientific school, and recently connected with the biological department of the Johns Hopkins university, having been appointed assistant professor of biology, will assume charge of the biological laboratory at the opening of the next school year, and will give the instruction in physiology, botany, and general biology, now provided for in the regular courses of the institute, especially in the so-called natural-history course, as well as take charge of the work of special students in these branches.

The instruction given in geology by Professor Niles, and in zoölogy and paleontology by Professor Hyatt, will be continued. Mr. W. O. Crosby has been appointed assistant professor of mineralogy and lithology, and will hereafter give, throughout the school year, the instruction which has heretofore been confined to a single term. The advantages of the extension of the chemical and physical laboratories, abundantly provided for in the new building of the institute, will be enjoyed by the students of the natural-history course, in common with those of the other regular courses.

In view of the foregoing enlargement of facilities and opportunities for study and research in the branches especially embraced in this course, it is recommended to students looking forward either to becoming naturalists, or to the subsequent study and practice of medicine.

NOTES AND NEWS.

The comet recently detected by W. R. Brooks at Phelps, N.Y., has become an object of unusual interest since its identification with the comet of 1812, the return of which has been anticipated about this time. Mr. Brooks first noticed the comet as a suspicious object on the night of Sept. 1, and directed the attention of astronomers to it, after a second observation. During the first half of September it was repeatedly observed at various places; but its great distance and consequently slow movement made it difficult to obtain trustworthy approximations to its orbit, and thus delayed the recognition of its character. Its identity with the comet of 1812 was first announced, so far as we are informed at present, by the Rev. George M. Searle of New York, in a letter published on Sept. 18. A communication from him to Harvard college observatory, with which he was formerly connected, was received there on the morning of Sept. 20, and contained a statement of the process by which he reached the interesting conclusion previously announced. This consisted in determining, from the positions of the Brooks comet, the corresponding points of intersection with Encke's orbit of 1812; the result for the time of perihelion passage being 1884, Jan., 25.17, and the longitude of the perihelion being closely accordant with that given by Encke.

Professor Boss of the Dudley observatory, as will be seen on an earlier page, arrived independently at the same conclusion by computing parabolic elements from observations of Sept. 5, 9, and 18, which exhibited a close similarity with those of the orbit of 1812. The circular which he has issued upon the subject states that he communicated his result to the associated press on the evening of Sept. 19.

The communication of Father Searle to Harvard college observatory, already mentioned, induced Mr. Chandler to examine the question, with the aid of the most recent observations. The result was to furnish further confirmation of the asserted identity; and the positions obtained at the observatory as late as Sept. 22 make it still more evident. The difference between the observed place and that resulting from the orbit of 1812, as corrected by the recent publication of Schulhof and Bossert, but with the time of perihelion passage assumed as 1884, Jan., 25.780, is as follows: —

Diff. R.A. — $0^s.1$. (O—C.)
" Decl. + 66″.

This agreement is entirely within the uncertainty of the orbit of 1812, from the old observations.

The comet has also exhibited phenomena of great interest in regard to the development of its structure by its approach to the sun. When first observed this year, it was a very faint and small nebulous object, but the appearance of a stellar nucleus was noted at Harvard college observatory by Mr. Wendell on Sept. 3. The nucleus was afterwards less distinct. This may have been due to unfavorable conditions of observation, or it may possibly indicate a preliminary series of changes like those which the comet has just exhibited. On Sept. 21, as seen at Harvard college observatory, the comet was still very faint. A slight condensation at one place could be seen with the large equatorial, but this could hardly be called stellar. The next night, Sept. 22, the appearance of the comet had so completely changed that it was difficult to believe it the same object previously seen. It now resembled a star nearly as bright as one of the eighth magnitude. Very little nebulosity could be detected about it, but some was seen early in the evening, while the comet was sufficiently high in the sky. During the evening it appeared to be gaining perceptibly in brightness. The next night, Sept. 23, it was seen at times between clouds, and was found to have again changed its appearance. It was now even brighter than before (although still slightly inferior to a star of the eighth magnitude), but it had lost its stellar appearance, and had become blurred, regaining the ordinary character of a cometic nucleus. Traces of the development of a tail were also perceptible. The rapidity of this series of changes is very unusual, if not unexampled.

The comet will doubtless become visible to the naked eye, and will prove an interesting object, although it cannot at present be confidently expected to rival the fine comets of recent years in apparent dimensions and brilliancy.

— Nordenskiold has returned from his exploration of the interior of Greenland, without fully effecting his purpose. From the contradictory reports that have been published by the daily press, we gather that he entered the interior from Auleitsivik Bay, near Disco Island, and himself penetrated to the distance of nearly ninety miles, when the snow became too soft for sledges. His Laplanders pushed much farther on snow-shoes, or about half way across the continent, if they took a direct easterly course, of which we are not assured. On the east coast his vessel subsequently pushed as far northward as Cape Dan, but was prevented from making its way farther northward by the ice.

— The first of the authoritative publications of the International fisheries exhibition contains an excellent account, by G. Brown Goode, of the fishery industries of the United States, both historical and statistical, including all the marine products that are derived from the animal and vegetable life of the seas, as well as a careful though condensed account of the labors of the federal fish commission.

— Professor Simon Newcomb, U. S. Navy, superintendent of the *American ephemeris* and *Nautical almanac*, Washington, and Dr. Benjamin Apthorp Gould, director of the National observatory at Cordoba, Argentine Republic, have been elected corresponding members of the Berlin *Akademie der wissenschaften*.

— According to *Nature*, the balloon of the Paris observatory has been in working order for some weeks. Its capacity being only sixty cubic metres, it was found difficult to use it, except in calm weather. The motions of the registering apparatus are an obstacle to correct readings. The experiments, conducted by Admiral Mouchez, are stated to be only preliminary to further aerostatical experiments. The subject is quite new, scientific ballooning being only in its infancy; and it is only by gradual investigation that the extent of the services it can render to science can be ascertained.

— Professor P. Denza discusses in the *Comptes rendus* the question of the connection between eclipses and terrestrial magnetism. From the time of the total solar eclipse of Dec. 22, 1870, regular observations of magnetic declination have been made at the observatory of Moncalieri during the progress of all eclipses of the sun, as well as some eclipses of the moon. The needle has been observed at intervals of only a few minutes on such occasions; and the entire series of observations extends through twenty eclipses, the last being the Egyptian solar eclipse of May 17, 1882. His discussion indicates no connection between the amount of magnetic disturbance and the magnitude of solar eclipses; and in general it may be regarded as established from his investigation, that the passage of the moon between the earth and the sun in eclipses of the latter, and the passage of the moon through the shadow of the earth in eclipses of the former, have no influence whatever upon terrestrial magnetism.

— The *Illustriste zeitung* reports that the fossil remains of several iguanodons have been found at Bernipart, in Belgium. The skeleton of one of these fossil monsters has been carefully put together, and removed to the Natural history museum at Brussels, where a special case has been made for it, and placed in the courtyard, no convenient space being found inside. The same journal reports the discovery of the remains of animals of the bronze age, made during the extension of the fortifications of Spandau. Among other things were the bones of a species of dog, the leg-bone of a gigantic horse, and the bones of a small species of pig, somewhat like the present Indian one. The remains have been examined by Professor Nehring, who also discovered the remains of a small-limbed goat and of a sheep.

— Mr. Winslow Upton, of the U. S. signal office at Washington, has been elected professor of astronomy at Brown university, Providence, R.I. It is understood that his acceptance of the position is conditional upon the erection of an astronomical observatory which the college authorities have under consideration.

— Professor Piazzi Smyth has published his views upon the subject of a prime meridian for the whole world. They furnish an excellent illustration of the fact that a man's peculiar opinions on any one subject may warp his judgment upon matters wholly removed from it. He advocates the adoption of the meridian of the Great pyramid, because it "passes over solid, habitable, and for ages inhabited, land through nearly the whole of its course from north to south. Its line is capable, therefore, of being laid out along almost all that distance by trigonometrical measurement, and marked by masonried station-signals." Among other equally cogent arguments are the statements that the pyramid "dates from before all human written history, all known architecture, all living architecture;" that "its meridian divides the lands and numbers of the people of the earth much more nearly than any other;" and that it passes not very far from Jerusalem, near which the prime meridian of the world ought to be located by Christian people.

The last idea is developed more fully by M. du Caillaud, who has addressed a letter to the president of the Paris geographical society, urging the adoption of the meridian of Bethlehem, thus harmonizing the longitude reckoning with the customary method of numbering the years from the birth of Christ.

— At Wabash college, Crawfordsville, Ind., a new laboratory is in process of erection, which is to be devoted entirely to biological work. One room, 50×100 feet, with balcony and side-aisles, will contain the general collection of many thousand specimens; a second room will contain the herbarium of twenty thousand species; and a third will be devoted to other collections. Special students are directed to the fact that the collection of crinoids from the Keokuk beds in the vicinity is complete, and that botanical material is on hand in great abundance for consultation. There will be three laboratories provided with every needed appliance, — one for general botanical work, the second for zoölogical work, the third for special work with compound microscopes. The last laboratory, in particular, is to be devoted exclusively to original research.

— Frederick A. Fernald, in criticising, in the September *Century*, Mr. A. Melville Bell's paper in SCIENCE for June 1, objects to the forms of the visible-speech letters which Mr. Bell would employ as symbols for the six consonant sounds in our language which have no proper letters to represent them, and suggests the discarding from their present use in our alphabet of the duplicated symbols *q*, *x*, and c, and using them instead for the sounds represented by *ng*, *zh*, and *ch*. "Perhaps it will be decided to replace *w* and *y* by vowels, as in Franklin's scheme; if so, these, with one Anglo-Saxon letter, alredy lookt upon with favor, would make up the six lacking consonants." To this suggestion it may be objected, that the use of familiar letters in an unfamiliar sense would be a source of constant confusion. For example, we should have to read cat and coke as *chat* and *choke*, pleaxure as *pleasure*, roux as *rouge*, sig as *sing*, etc. The alterations of spelling, too, would be seriously numerous; as in siks for *six*, egzist for *exist*, kueen for *queen*, knite for *quite*, etc. The use of the Anglo-Saxon þ and ð for the two sounds of *th* would certainly be an improvement on present practice; but the writing of *w* (in *way*) and *y* (in *yea*) as vowels would be altogether wrong, as these sounds are demonstrably not vowels, but consonants. *Wh*, also, is a true consonant, — the non-vocal correspondent of *w*, — and has not, as alleged, the sound of *hoo*. If *wh* had this sound, the sentence, "I saw the man whet the knife," would not be — as it is — unmistakably distinct from "I saw the man who ate the knife." *Ch* (in *chair*) is not, as alleged, a simple consonant, but a compound consisting of a shut position of the tongue (*t*), followed by a hiss (*sh*); and either the silent position or the hiss may be prolonged *ad libitum*.

"Even *such* a man, so woe-begone," etc.

Give due lingering emphasis to the word 'such,' in the above quotation, and the compound character of the *ch* — misunderstood by many writers — will be apparent. The letter c should consistently stand for *sh*, not *ch*, in Mr. Fernald's proposition; but, if a better method of completing our alphabet cannot be adopted, by all means rather let the A B C remain as it is.

— *Le Temps* has published the following directions by Pasteur to those exposed to the contagion of cholera.

The precautions to be taken, indicated to the members of the French cholera commission, all relate to the case when it is necessary to guard against the excessive causes of contagion.

1°. Do not use the potable water of the locality, when the commission enters on its investigations, without having first boiled the water, and, after it has cooled, shaken it for some minutes (two or three minutes are sufficient) in a bottle half full and corked.

One may use the waters of the locality, provided one draws them at a spring, in vessels which have been purified by exposing them to a temperature of 150° C., or, better, to a higher heat. One can advantageously employ natural mineral waters.

2°. Use wine which has been heated in bottles some 50° to 60°, and drink from glasses likewise purified.

3°. Only make use of food thoroughly boiled, or of fruits well washed with water which has been boiled, and which has been kept in the same vessels in which it was boiled, or which has been transferred from these vessels to others disinfected by heat.

4°. The bread used should be cut in thin slices, and kept at a temperature of 150° C. for twenty minutes or more.

5°. All vessels used for food should be exposed to a temperature of 150° C. or more.

6°. Bed linen and towels should be plunged in boiling water, and dried.

7°. Water for washing should be boiled, and have added to it, after cooling, one five-hundredth part of thymic acid (one litre of dilute alcohol for two grams of acid) and one-fiftieth part of phenic acid (one litre of water for twenty grams of acid).

8°. Wash the hands and body often during the day with the boiled water to which the thymic or phenic acid has been added.

9°. It is only in case one has to handle the bodies of those who have died from cholera, or the clothes and linen soiled with their discharges, that it is necessary to cover the mouth and nostrils with a mask, formed of two pieces of fine wire gauze, with wadding between, one centimetre thick. The mask should be exposed to a temperature of 150° each time before it is used.

— The Wisconsin agricultural experiment-station was organized by the board of regents of the University of Wisconsin, in June, 1883. The work of the station is in charge of W. A. Henry, agriculture; William Trelease, botany and horticulture; H. P. Armsby, agricultural chemistry. The bulletins of the station will be sent to all interested. The first number contains an account of experiments at the station in feeding skim-milk to calves and pigs.

— Mr. C. F. Mabery has resigned his position at Harvard college, and accepted the chair of chemistry at the recently organized Case school of applied science at Cleveland, O.

— The British association for the advancement of science will meet next year in Montreal, on Aug. 27.

— Next year's meeting of the Swiss naturalists will be held at Lucerne.

— The jury which will examine the electric lighting machinery offered for competition at the Cincinnati industrial exposition has begun its work. It is hoped that the comparative tests will be the most satisfactory yet obtained. Awards of five hundred and three hundred dollars will be made for the best and second best systems of electric lighting, both incandescent and arc.

— We learn from *Symons' meteorological magazine* for August, that the government has granted Professor Lemström a sum of 37,000 marks for the continuation of his auroral experiments in Finnish Lapland. These investigations will include the electrical current which produces the aurora, terrestrial currents, and magnetic perturbations.

— Professor Henry F. Osborn of Princeton has published in the July number of the *Quarterly journal of microscopical science*, in a more extended form and with the accompaniment of a lithographic plate, the results of his researches on the foetal envelopes of marsupials. The interest and importance of these investigations are already known, at least to the embryologists among our readers, for Professor Osborn's conclusions were first published in SCIENCE.

— The thirty-eighth volume of the *Mémoires du dépôt de la guerre*, recently printed by the Russian general staff under the editorship of Rylke, and of which only one hundred and fifty copies are issued, contains, among other things, an account of the astronomical and trigonometrical work in eastern Siberia, by Bolsheff, Polianoffski, and Kramereff; a memoir of Kulberg on the Russian geodetic operations in Armenia; a report by Lebedeff on triangulation, topographic and astronomical work in Bulgaria; a list of astronomical stations in the Khirgiz steppes by Bondorf; and Stebnitzki's report on the results of his experiments with a reversible pendulum. Of this important work, absolutely necessary for those seriously interested in the study of the geography of Russia and adjacent countries, there is probably not a copy in America.

— Mr. Miles Rock, assistant astronomer at the U.S. naval observatory, has accepted the appointment of chief astronomer and engineer commissioner on the international boundary commission of Guatemala, to locate the boundary between that country and Mexico. He will sail from New York Oct. 1, and expects to be absent about a year.

— Professor H. M. Paul, late of the Imperial university of Tokio, has returned to this country, and accepted a position in Washington under the Transit of Venus commission.

— The *Comptes rendus* of Aug. 13 gives some extracts from a letter of M. A. Richard to M. de Lesseps, on the cultivation of date-palms. M. Richard states that these palms grow best on a soil saturated with salt, as has been proved at Alicant and elsewhere. The land around Elche, in Valencia, is irrigated from the Vinalopo, which is extremely salt, rising, as it does, in Mount Pinoso, the rocks of which contain much salt and sulphate of lime. This water, having been used for centuries for watering the palm-plantations, has at last formed a crust, which has to be broken with a pick-axe to admit the water below. The town of Alicant has planted its beautiful boulevard along the shore with date-palms, and, as fresh water is very precious there, the trees are regularly watered with sea-water. All the plantations recently made along the shore from Huertas to Rio Monegro have their roots literally in the sea-water, being planted at but a few feet from the sea.

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SCIENCE.

FRIDAY, OCTOBER 5, 1883.

NATIONAL TRAITS IN SCIENCE.

THERE are at present three principal currents of scientific work, — German, English, and French. The scientific writings of each nationality are characteristic, and, taken as a whole, offer in each case distinctive qualities. German influence is now predominant over the scientific world, as French influence was uppermost during the earlier part of this century; but the sway of Germany over western thought is far more potent and wide-spread than was ever that of France. As students once gathered in Paris, so they now flock to Germany; and thence back to their own lands they carry the notions of German science, and labor to extend, imitate, and rival them. Thus German ideas have been spread abroad, and established in foreign countries. This has set a common standard for scientific work, which is accepted in most European countries. German influence is evident by its effects in Switzerland, Russia, Italy, Poland, Belgium, England, and America, and in degrees indicated by the order given: in France, Spain, and Portugal, it is hardly noticeable. Holland and the Scandinavian countries have for many years achieved so much and so excellent work, that their scientific development may be said to have accompanied rather than to have followed that of Germany.

German science has unquestionably distinctive qualities. Its pursuit is a special and honored calling, attractive to the highest talent: its productions have the stamp of professional work. The German scientific man is first and principally an investigator: he is obliged to be so, otherwise he loses in the race. He wins his position in the hierarchy of learning by the original researches he carries out. To succeed under these circumstances, a man must discover something which is a real addition to knowledge; and to do this, he must be thoroughly familiar with all that has been previously accomplished in his field. Moreover, to advance beyond his peers, the investigator must utilize every possible extraneous advantage; more especially must he have a mastery over the methods to be employed, and be familiar with all novelties and refinements therein. It cannot be gainsaid that these requirements are more fully answered in Germany than anywhere else. It is certain, that, excepting of course a small minority, German scientific publications always contain something really new, and unknown before: each article is a scientific progress, which, however slight, still brings an actual increment to our store of information. Another result of this professional thoroughness is equally striking and characteristic. Being fully posted as to the status of his department, the German often displays a singularly just and keen appreciation of what problems are for the moment best worth studying, as being open for solution, and leading to something farther, or else filling a gap left. He is thus enabled to render his work efficient. It is sad to think how much scientific work is wasted because the labor is not wisely directed.

In German scientific writings the excellence of the matter usually contrasts vividly with the defective style and presentation.. Indeed, the Germans, despite the superiority of their modern literature, are awkward writers, and too often slovenly in literary composition. Conciseness and clearness are good qualities, which may assuredly be attained by the expenditure of thought and pains; but these the German investigator seems unwilling, in many cases, to bestow upon his pen-work, but follows the easier plan of great diffuseness. Besides this, another defect is not uncommon, — the ill-considered arrangement of the matter. This occurs in all degrees, from a well-nigh incredible confusion, to be sometimes found even in elaborate and important essays, to a slightly illogical order. In this regard, a curious and not infrequent variety of this fault deserves mention. According to the headings of the chapters or sections, the division of topics is perfect; but under each head the matters are tumbled together as if a clerk was contented to stuff his papers in anyhow, if only he crammed them into the right pigeon-hole.

Speaking broadly, the German mind lacks conspicuously the habits of clearness and order. There have been celebrated exceptions, but they were individual. The nation regards itself as having a decidedly philosophical bent, meaning a facility at taking broad and profound views of the known. We venture to contradict this opinion, doing it advisedly. Their profundity is mysticism, their breadth vagueness, yet a good philosopher must think clearly. It is a remarkable but little heeded fact, that Germany has not contributed her share to the generalizations of science: she has produced no Linné, Darwin, Lyell, Lavoisier, or Descartes, each of whom bequeathed to posterity a new realm of knowledge, although she has given to the world grand results by the accumulated achievements of her investigators. The German's imperfect sense of humor is another obstacle which besets him on every path. He is cut off from the perception of some absurdity, like that of Kant's neumenon, for instance. One cannot explain this to him: it were easier to explain a shadow to the sun, who always sees the lighted side. To state the whole epigrammatically, German science is the professional investigation of detail, slowly attaining generalizations.

English science is the opposite of this, — amateurish rather than professional. Some might call it insular, yet we should hardly join them in so doing. In fact, the professional investigator has hardly been a recognized character in the English social organization: until recently he was barely acknowledged, even by the universities, which sought instructors who knew and could teach, who might investigate and discover in a subsidiary, and, as it were, unofficial way. A large number of English scientific men were disconnected from the universities and colleges after their own student years, and were half or wholly amateurs; and their writings show the effects of this separation, not always, to be sure, but in many cases with painful evidence, by a lack of thoroughness, an imperfect acquaintance with other investigations, and a failure to grasp the essential part of the problem: in brief, such writings appear behindhand and superficial. Yet amid these poorer productions are to be found a right goodly number of the best scientific articles we possess in any language. Of late years the proportion of the good has steadily increased, and investigation is now more correctly appreciated than ever before. Indeed, there is no more encouraging event in the recent progress of science than the sudden elevation of the standard of original research in England. The English are trained writers: their scientific articles excel the German in literary merit, being seldom slovenly either in arrangement or style, and rarely wearisome from sheer diffuseness. Very noteworthy is the fertility in generalizations of the English: this is with them the outcome of individual endowments, a single master attaining a broad conclusion, — a process of individual effort quite unlike the German democratic method of generalizing by the accumulations of many. Is it too much to say that the English and Scotch are the Greeks of modern philosophy?

French science is decidedly provincial: it is apart, having only an imperfect, uncertain acquaintance with the great world outside, and its international interests of original research. The French have lagged far behind the great movements of recent years. Consider only how backward they have been in the comprehension and acceptance of the Darwinian theory; and remember, too, that it were wiser to take out the mainspring from a watch than to eliminate evolution from biology. French scientific articles are well written, the matter is admirably classified, it is all very clear. The keen, artistic sense of the nation displays itself here; but it also deludes them into presenting a rounded survey of a greater field than is demanded by the actual discoveries they report. To satisfy this yearning for artistic completeness, elaborate and tedious disquisitions, and hackneyed principles, and facts long known, are interpolated; and even worse may be, when the imagination helps to create the completeness. Most scientific men harbor a little distrust of French work. This sentiment is further fostered by the almost systematic neglect of German research on the part of the French. Such a frank exhibition of rancor makes one suspect the impartiality of the French in science generally: indeed, we believe that science has never been so depressed in France as at present. Italy is above her; but Italy, with all her innate ability, is striving to learn from Germany, and has already risen high, and will rise higher. We trust and believe that the present phase of French science which abounds in inefficient work will soon end, and the people terminate their present voluntary isolation. The French stay at home: they used to travel abroad much. Let us hope that they will soon resume their ancient habit, and, above all, that they will re-establish mental intercourse with foreigners. There are *savants* in France who are esteemed throughout the scientific world: may their number rapidly increase!

America's contributions to pure science are by no means very extensive, or often very important: compared with the great volume of German production, they seem almost insignificant. We have never duly fostered research, for we have bestowed upon it neither the proper esteem nor office. There are, we suppose, at least six thousand 'professors' in the United States: are one hundred and fifty of them active investigators? The time seems remote when every American professor will be expected to be also an investigator; but among us is a little band of men who have before them the model of Germany, and who are working earnestly for the intellectual elevation of their country. Their first object is necessarily to render research more important in public estimation, and so to smooth the way for a corps of professional investigators. Every thoughtful person must wish success to the attempt.

CLIMATE IN THE CURE OF CONSUMPTION.[1] — II.

Humidity.

There is a unanimity of opinion amongst authorities in regard to the relation of moisture to the production of phthisis. The seventh annual report of the registrar-general of Scotland showed that the death-rate from phthisis diminished in proportion to the dryness of the location. Dr. H. I. Bowditch of Boston has shown that phthisis is prevalent in damp soils in the United States. "It is also common in Holland, and other countries liable to damp fogs and an atmosphere saturated with moisture" (Reynold's System of medicine, iii. 548). Ruehle, in Ziemssen, says, "It appears that moist air favors consumption." Dr. Austin Flint says, "It may be stated that the prevalence of the disease is less in climates either uniformly warm and dry or uniformly cold and dry." And Dr. C. T. Williams writes, "As to the desirability of moist climates for consumptive patients, the evidence is decidedly against their use in the treatment of ordinary chronic phthisis."

If we attempt to explain why it is that phthisis is more prevalent in moist climates than in dry, we might assign as a cause the prevalence of germs, or the impurity of the air, containing the effluvia of decay, or perhaps the greater susceptibility of the system to cold in moist climates; or it may be that the air, being so near saturation, cannot take up the requisite amount of the aqueous vapor exhaled from the lungs. *Causa latet vis est nota* may adequately express the state of our knowledge in regard to this point. A moist climate is acknowledged to be a breeder of phthisis; and, *au contraire*, a dry climate is known to afford a certain exemption from the disease. This is shown by the fact that the disease is rare in Iceland, in the island of Morstrand, on the steppes of Kirghis, and in the interior of Egypt; in all of which places the element of elevation is wanting. It may, then, be conceded, that dryness of the air is an important element in the prophylaxis and cure of phthisis.

The method of determining the humidity of the air is that introduced by Regnault, known as the wet- and dry-bulb test. It can easily be seen that the results obtained will depend on the exposure of the thermometers, and on the accuracy of the readings. Moreover, the amount of moisture that the air is capable of

[1] Concluded from No. 34.

holding varies with the atmospheric pressure and temperature.

While it seems to us that a table showing the relative humidity, i.e., the percentage of saturation of the air, would be sufficiently accurate as a basis of comparison, yet, as it might be objected that such a table would be subject to error, we have appended another table, giving the absolute moisture, or the number of grains of vapor to the cubic foot of air. This second table we have computed from Glaisher's tables.

Consulting these tables (table I., columns iii. and iv.), it is seen that Denver and Santa Fé afford a very low relative and absolute amount of atmospheric moisture, — a relative amount, which, as between Denver and Jacksonville, is as 1 to 3, and, as between Denver and Los Angeles, is as 1 to 2.

This proves, that, on the eastern slopes of the Rocky Mountains, we have, in addition to the favorable element of elevation, a second, that of dry air, as an element of climatic influence in the cure of phthisis.

Precipitation.

Closely related to the foregoing, is a consideration of the mean annual precipitation, or the mean annual amount (in inches) of rain and melted snow. Its bearing on our subject is apparent in several ways.

1. Of the precipitation, a certain part is lost by evaporation, and tends to increase the humidity of the air. This amount will depend upon the amount of moisture in the air, or its degree of saturation, and also upon the amount of the precipitation left upon the surface of the ground to be evaporated. It is evident that the greater the porosity of the soil, the greater will be its absorptive power, and the less the evaporation from it. Such a porous soil is found on the eastern slopes of the Rocky Mountains. Loose, sandy, and gravelly, it eagerly drinks up all the rainfall; and such a thing as mud is rarely seen.

2. It is well known that pulmonary troubles are most prevalent during 'thaws,' in those places where the snow lies upon the ground in winter. Now, in the district of the Rocky Mountains under consideration, there is, in the first place, only a slight amount of snowfall, so that sleighing is exceptional, and, in addition, the warm sun soon melts the snow, and the thirsty, porous soil drinks it up; so that the annual 'spring thaw' of our Eastern States is a *res incognita* in this country. The writer remembers very distinctly several snowfalls of fourteen to twenty-two inches on a level, of which there was not a vestige left in ten days; and during that time the air was not chill and raw, and there was but little slush.

3. Further than this, the amount of the precipitation has a bearing upon our subject, as indicating approximately the ability of the invalid to lead an out-of-door life. We shall defer our discussion of this point to a later part of this paper.

Turning, now, to the tables, we see (table I., column v.) that in Denver the mean annual precipitation for a period of ten years is only 14.77 inches in rain and melted snow, — an amount which is only one-fourth of that at Jacksonville, and which, with Santa Fé, gives the smallest showing in our range.

We can therefore add this element of climate to the other two of elevation and dry air as a point in favor of the Rocky Mountains in the cure of phthisis.

Temperature.

The writer in Reynold's System (*op. cit.*) says of this matter of the relation of the temperature of climate to the cure of phthisis, "It was formerly supposed that warm climates were beneficial for consumptive patients. . . . But it will be invariably observed that unaccustomed warmth is injurious. . . . What is really required, is a cool, temperate climate, free from great alterations of temperature." Dr. Austin Flint (*op. cit.*) calls attention to the fact, that "the disease is oftener developed during the spring months and the hot months of summer," when either there is a great deal of moisture in the air, or the debilitating effects of heat are present as factors. On the other hand, Ruehle says that the temperature has "nothing to do with the prevalence of consumption."

It is known that the effect of heat is to raise the body temperature, to lessen the number of respirations, to quicken the pulse, to lessen the digestive powers and the appetite, to diminish the excretion of urea because of the diminishing of the ingesta, and to depress the nervous system, especially if the heat be accompanied with excessive moisture. It seems, then, that it can be stated as a fair inference from the foregoing, that a dry, temperate climate is to be sought by the phthisical invalid. The Rocky Mountains furnish a dry climate. The table (table I., column vi.) shows that the mean temperature is nearly a mean between the extremes in our range. The question will, however, be presented in a better form farther on.

Winds.

The points of importance in regard to the winds are their velocity and direction. It is well known that they are regulated somewhat by changes in atmospheric pressure and temperature.

Velocity. — It is known that a cold wind abstracts body-heat, and in proportion to its velocity. By consulting our tables (table II., part ii.) it will be seen that the mean daily velocity of the winds at Denver is less than it is in the Eastern States; and that as a consequence, while the mean temperature is nearly the same, the chilling effect will be much less. On the other hand, as it has a considerably greater velocity, and as there are fewer calms than at either Augusta or Los Angeles, it has a proportionately greater purifying power in bringing fresh ozone, and in blowing away the products of decomposition.

Direction. — Of more importance than the velocity, is the direction of the winds. The favorable and unfavorable directions vary for different places, according to their geographical location. The east and north winds are known to be the trying ones along the Atlantic coast; and our table shows that the north-east wind is the prevailing one at both Augusta and Jacksonville. The west wind, blowing from the Pacific Ocean, and bringing fogs, is the trying one on the California shore; and the table shows that this is the prevailing one at Los Angeles. The south wind is the salubrious one for the eastern slope of the Rocky Mountains, in Colorado; and our table shows that this is the wind that blows there most frequently.

We can therefore add this element to the others, — of elevation, dryness of air, small amount of precipitation, and mean temperature, — as favorable to the Rocky Mountains as a place for phthisical patients to resort.

Clear, fair, and cloudy days.

We now come to the consideration of our last general point, that is, to an investigation of the number of clear, fair, and cloudy days; or, in other words, to a consideration of the amount of sunshine.

As to the direct effect upon health produced by light and sunshine, we are still in ignorance. Whether the blood is made to course more rapidly, and the nerves transmit impulses more readily, under the influence of the solar ray, is not known. It is well known that the actinic rays have a powerful chemical effect upon vegetation; but whether or not they have a like influence upon the human economy is unknown.

Without attempting to refine, there are certain broad and positive effects in the cure of phthisis attributable to sunshine. The experience of the profession is fittingly expressed by the words of Dr. Austin Flint: "I would rank exercise and out-of-door life far above any known remedies for the cure of the disease."

TABLE II. — Winds.

Station.	Direction. Mean for three years.									Velocity.	Prevailing wind.
	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.	Mean daily.	Mean 5 years.
Augusta, Ga.	57	154	68	118	86	109	94	120	304	79 miles.	N.E.
Jacksonville, Fla.	77	282	120	116	102	180	83	76	60	159 "	N.E.
Boston, Mass.	70	59	88	72	85	155	286	186	60	238 "	W.
Newport, R.I.	113	80	51	73	112	299	183	164	28	236 "	S.W.
New York, N.Y.	76	136	54	98	83	175	188	290	14	207 "	N.W.
Philadelphia, Penn.	123	157	92	40	102	162	179	208	9	256 "	S.W.
Chicago, Ill.	147	122	85	99	142	239	151	114	30	203 "	S.W.
St. Paul, Minn.	95	37	91	223	72	122	129	223	70	211 "	S.E.
Denver, Col.	150	95	78	150	307	67	76	155	12	145 "	S.
Santa Fé, N. Mex.	139	109	157	100	78	142	59	119	201	152 "	E.
Salt Lake, Utah	81	64	56	252	39	33	49	269	249	135 "	N.W.
Los Angeles, Cal.	104	155	60	58	55	208	274	53	142	103 "	W.

In the table which we present (table III.), and which is a mean of daily observations for a period of five years, a cloudy day is one in which the heavens are from seven-tenths to entirely obscured by clouds; a fair day is one in which the heavens are from four to seven-tenths clouded; all else are classed as clear days. From this it will be seen, that for our purposes clear and fair days may be classed as one, and may be put into juxtaposition with the cloudy days. Consulting these tables, it will be seen, that in Denver the mean number of cloudy days in a year is only one-half of what it is in either Augusta or Jacksonville, that it is less than a half of what it is in St. Paul, and that it is slightly less than what it is in Los Angeles.

TABLE III.

Station.	Mean for 5 years.		
	Clear.	Fair.	Cloudy.
Augusta, Ga.	123	150	92
Jacksonville, Fla.	126	152	87
Boston, Mass.	105	145	115
Newport, R.I.	108	140	111
New York, N.Y.	101	155	109
Philadelphia, Penn.	114	139	112
Chicago, Ill.	104	154	107
St. Paul, Minn.	103	158	104
Denver, Col.	177	142	46
Santa Fé, N. Mex.	174	148	41
Salt Lake, Utah	141	131	93
Los Angeles, Cal.	164	148	51

To put this fact in another way, it is seen, that in Denver there is only about one-eighth of the entire year when an invalid would be kept in the house on account of the weather; in Jacksonville and Augusta he would be confined to the house, for the same reason, one-quarter of the year; in St. Paul he would be kept in-doors between a third and a quarter of the time; while in Boston he would have to be housed a good third of the time.

Admitting, then, the force of Dr. Flint's statement, our tables show that there is no place in this whole country, where it is possible for the invalid to enjoy so much fresh air and sunshine, as in the Rocky Mountains. For three hundred and twenty days out of every three hundred and sixty-five it is possible to roam at large, and to breathe in health.

We feel, that, so far, our tables have shown that the Rocky Mountains furnish climatic conditions of elevation, humidity, precipitation, temperature, winds, and sunshine, which recommend them as a resort for phthisical invalids superior to any thing to be found in this country.

Observations by seasons.

Having arrived at these general conclusions, the writer wishes to call attention very briefly to their accuracy and importance as applied to the different seasons of the year. He wishes to lay stress upon the evidence which goes to show that Colorado and New Mexico furnish favorable resorts for phthisical invalids during the winter and spring, — the very seasons that are most trying in the east, the seasons that they are obliged to avoid, and to seek new abodes at the resorts. The elements of elevation and barometric pressure will remain nearly constant the year round. But how is it in regard to the *humidity* of the air in Colorado during the winter and spring? The writer has selected at random, and without reference to whether the showings would be favorable or unfavorable for a given place, the year 1880 as his basis for comparison. By referring to table IV., part i., it will be seen, that both the relative and absolute humidity for Denver during the winter and spring is absolutely, and by comparison, very small; that, as compared with Augusta and Jacksonville, it makes a wonderful showing in these respects; and that the ratio of the absolute humidity as between Denver and Los Angeles is as 1 to 3 for these seasons.

When we turn to our tables (table IV., part ii.), we learn that the amount of *precipitation* at Denver for these seasons was almost *nil;* that the mean monthly precipitation at Denver for the given time was only a small fraction of an inch in rain and melted snow. Carry out, now, the comparison between Denver and Augusta, Jacksonville and Los Angeles, and see the tremendous difference in this particular between these places, — a showing immensely in favor of Denver. It will be seen that our general conclusions are very much strengthened by this particular application, and that we have brought strong additional evidence in favor of Colorado as a resort for persons affected with phthisis pulmonalis.

When we turn to our tables to learn in regard to the *winds* at these places for the given seasons, we see that the conclusions previously reached in regard to Denver, in this particular, still hold true (table V.).

Temperature. — We come now to our last observation, and to a brief discussion of what some may consider the weak point in regard

TABLE IV.

Station.	1880. Relative and absolute humidity. Spring. R. H.[1]	Spring. G. V.[2]	Summer. R. H.	Summer. G. V.	Autumn. R. H.	Autumn. G. V.	Winter. R. H.	Winter. G. V.	1880. Precipitation. Spring.	Summer.	Autumn.	Winter.
Augusta, Ga.	68	4.7	64	7.2	74	4.9	72	3.2	5.0	4.2	2.8	3.0
Jacksonville, Fla.	66	5.5	69	8.0	75	5.6	70	3.0	3.5	5.9	0.5	3.5
Boston, Mass.	61	2.5	70	5.4	67	3.0	69	1.5	2.6	3.5	2.6	3.8
Newport, R.I.	71	2.7	76	5.9	75	3.5	76	1.9	3.9	5.0	3.4	3.6
New York, N.Y.	65	2.0	79	5.5	70	3.8	65	2.0	2.5	4.2	2.5	2.8
Philadelphia, Penn.	61	2.7	66	6.1	68	3.0	72	2.1	2.1	4.8	1.5	2.6
Chicago, Ill.	63	2.9	70	5.9	66	2.3	69	1.8	4.1	3.7	2.1	2.4
St. Paul, Minn.	62	2.9	69	5.1	66	2.9	71	–	2.1	4.0	2.3	1.5
Denver, Col.	37	1.1	43	3.3	55	2.3	51	0.9	0.5	1.3	1.0	0.2
Santa Fé, N. Mex.	35	1.2	36	2.6	50	2.5	50	–	0.2	1.7	0.7	0.6
Salt Lake, Utah	41	1.5	25	1.5	33	1.6	50	1.3	1.6	0.3	0.7	1.1
Los Angeles, Cal.	74	3.6	73	4.8	63	3.8	68	2.9	2.2	0.6	0.3	3.8

[1] Relative humidity. [2] Grains vapor.

to Colorado as a resort for invalids. It has been seen that most authorities favor a cold climate; but they add the proviso that it should be free from change. By consulting table VI., part ii., it will be seen that the mean monthly range of temperature is larger for Denver than for almost any other point in our scale. It will be seen, further, that the minima (table VI., part i.) of temperature are very nearly the lowest in the scale, — not so low, to be sure, as the minima at St. Paul, but decidedly lower than at Augusta, Jacksonville, and Los Angeles. This state of affairs demands an explanation.

We have seen that the air of Colorado is both dry and rare, — two conditions that favor rapid radiation. We have seen, further, that the soil is of a porous, sandy nature, — a kind

TABLE V. — Winds, 1880.

Station.	Direction. Spring.	Summer.	Autumn.	Winter.	Velocity, mean daily. Spring.	Summer.	Autumn.	Winter.
Augusta, Ga.	S.E.	S.E.	N.E.	N.W.	102	77	67	101
Jacksonville, Fla.	N.E.	S.W.	N.E.	N.E.	226	162	157	189
Boston, Mass.	S.W.	S.W.	W.	N.W.	257	184	223	281
Newport, R.I.	S.W.	S.W.	S.W.	S.W.	243	168	232	266
New York, N.Y.	N.W.	S.W.	N.W.	N.W.	247	177	192	222
Philadelphia, Penn.	S.W.	S.W.	N.W.	S.W.	294	218	228	178
Chicago, Ill.	S.W.	S.W.	S.W.	S.W.	182	183	217	193
St. Paul, Minn.	S.E.	S.E.	N.W.	S.E.	210	180	189	193
Denver, Col.	S.	S.	S.	S.	156	143	115	127
Santa Fé, N. Mex.	S.W.	N.E.	N.E.	N.W.	167	134	140	148
Salt Lake, Utah	S.E.	N.W.	S.E.	S.E.	122	130	102	103
Los Angeles, Cal.	S.W.	W.	W.	N.E.	187	131	78	112

TABLE VI.—TEMPERATURE, 1880.

STATION.	SPRING.		SUMMER.		AUTUMN.		WINTER.		SPRING.		SUMMER.		AUTUMN.		WINTER.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Range.	Mean.	Range.	Mean.	Range.	Mean.	Range.	Mean.
Augusta, Ga.	90	35	99	60	91	28	81	7	47	66	32	81	45	63	54	51
Jacksonville, Fla.	95	42	100	69	91	39	78	19	43	71	29	82	39	69	45	59
Boston, Mass.	92	12	101	47	93	3	59	—5	58	47	48	69	52	51	52	33
Newport, R.I.	84	14	88	49	87	15	61	1	44	47	33	69	42	53	48	36
New York, N.Y.	94	16	92	48	91	14	65	—6	54	51	36	72	45	53	52	36
Philadelphia, Penn.	96	20	95	51	91	10	67	—5	56	54	37	75	49	55	53	37
Chicago, Ill.	85	19	95	52	85	1	63	—15	47	51	42	72	53	48	57	31
St. Paul, Minn.	91	—7	98	47	90	—18	59	—27	59	46	43	89	62	42	67	21
Denver, Col.	89	—10	96	39	89	—13	59	—11	66	48	48	69	60	44	72	29
Santa Fé, N. Mex.	80	0	88	33	80	—11	56	—3	67	47	45	66	59	48	61	27
Salt Lake, Utah	78	5	95	40	88	3	49	2	51	45	51	68	51	49	44	31
Los Angeles, Cal.	97	36	87	50	91	35	80	30	45	56	38	64	47	61	46	54

that will easily absorb heat, and as easily give it off. Furthermore, there is but little verdure or shade, — another condition, too, which will favor both absorption and radiation of heat. In consequence of these conditions, the soil and air are, on the one hand, rapidly heated in the morning, and they are equally rapidly cooled at night. The nights are always cool in Colorado, — a condition that renders the summer months enjoyable and invigorating. But the question, after all, is, whether this diurnal change of temperature is injurious to Colorado as a resort for invalids. We claim that it is not, and for this reason: it makes but little difference to the invalid how cold the nights are, for at that time he should be indoors, where he can regulate the temperature; but it is of importance that it should be warm at mid-day, so that he can take his exercise regularly and comfortably. We have seen, that so far as conditions of sunshine, humidity, and rain and snow fall are concerned, the invalid can lead an out-of-door life a greater percentage of the time in Colorado than anywhere else in this country; and we claim that he will never find these factors counterbalanced by the element of temperature. An experience of several years warrants the writer in asserting that an invalid can, with perfect comfort and safety, spend several hours in the saddle nearly every day of the three hundred and sixty-five. One has but to read 'H. H.'s' writings to learn how attractive out-of-door life is in Colorado, even in mid-winter; and we can positively assert that we have known of picnics being held day after day, in the open air, in the very heart of the winter, and that there are days and weeks in mid-winter when one can sit with doors and windows open.

As proof of what we say, we append the mid-day temperature at Denver for each month of the year for three years.

In conclusion, the writer would state, that while his personal experience in regard to a desirable climate for the cure of phthisis has been such as to convince him of the great superiority of the climate of the Rocky Moun-

TABLE VII.—DENVER, MEAN MONTHLY TEMPERATURE, 1 P.M.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1880	45°.7	37°.6	44°.3	56°.7	67°.2	78°.5	79°.9	79°.6	71°.3	56°.8	30°.3	35°.8
1881	33 .5	38 .4	46 .1	62 .2	69	82 .5	84 .6	81 .3	70	69 .7	42 .8	47 .6
1882	37	48 .2	52 .3	65 .5	59 .3	73	81 .6	81 .4	73 .9	69 .4	46 .6	43 .2

tains over any other in this country, yet in this article he has tried to put aside any personal bias, and he desires to carry conviction only in so far as he has been able to adduce facts, and to interpret them rationally and logically. He would state, further, that, if the reader should take exception to any interpretation given to the facts, the tables still stand as the best and most reliable data of these facts attainable, and they are not to be controverted.

SAML. AUG. FISK, M.D.

Denver, Col.

REARING OYSTERS FROM ARTIFICIALLY FERTILIZED EGGS AT STOCKTON, MD.

IN order to test the feasibility of such an undertaking on a considerable scale, a pond three and a half feet deep was excavated on the premises of Messrs. George V. Shepard and H. H. Pierce, not far from Stockton, near the shore of Chincoteague Bay, and connected with the latter by a trench ten-feet long, two feet wide, and three and a half feet deep. Before the water was let into the trench connecting the pond with the bay, a wooden diaphragm — made in the form of a box three feet deep, and two and a half feet wide, and two inches thick, and lined on the inside with gunny-cloth; the sides of the box being perforated with numerous auger-holes, and filled with clean sharp sand, so as to form a filter — was placed in the trench vertically and transversely, and so secured that no water, except such as had first filtered through the diaphragm, could gain access to the pond. In this way the natural fry from the bay was effectually excluded from our artificial enclosure from the very start, so that the results of our experiment might not be vitiated. In the construction of this simple apparatus we depended entirely upon the rise and fall of the tide to partially renew the water in the pond in the intervals between the tides. The tidal rise and fall of the water in the enclosure was from four to six inches, or from six to eight inches less than the rise and fall of the tide in the open bay. Into the enclosure, covering about fifty square yards, artificially fertilized spawn was poured at odd dates, from July 7 to the first week of August.

The spawn was taken from the adults much in the same way as from fishes; the right valve of the adult animals being removed, and the ducts of the reproductive organs stroked with a pipette to force out the eggs and milt from the females and males. The products mixed together in water were then allowed to stand in pails for a few hours, until the eggs had developed as far as the swimming stage. The spawn so prepared was then distributed over different parts of the pond, and left to take care of itself.

The collectors used were simply oyster-shells strung upon galvanized wire; strings of shells being suspended to stakes driven into the bottom of the pond at intervals corresponding to the dates when fresh lots of spawn were introduced, each stake being marked with the date when it was put in place. The suspended oyster-shells were introduced so as to afford the young fry clean surfaces to which it could attach itself. On the 22d of August Mr. Pierce found that some of the shells hanging to the stakes had spat attached, ranging from one-fourth to three-fourths of an inch in diameter, and which had undoubtedly been derived from some of the brood placed in the pond by us. Some specimens of these young oysters are now in my possession, attached to the perforated oyster-shells used as collectors.

To our great surprise, we found that the water in the pond maintained about the same specific gravity as that in the bay, or 1.0175 to 1.018, and that the temperature of the water was also the same as in the open bay. The microscopic vegetable food upon which the oyster feeds was found to multiply rapidly in the enclosure, inasmuch as it was confined by the gate or diaphragm, so that it could not escape. The water in the pond was also found to remain sweet, and free from putrefactive odors. It will accordingly be seen, that all the conditions of success had been established, as was fully proved by the result.

While it is too soon to affirm that artificial breeding may be profitably available on an extensive scale in practical oyster-culture, our experiment has demonstrated a number of very important facts. These are: 1. Oyster-spat may be reared from artificially fertilized eggs; 2. The spat will grow just as fast in such enclosures as in the open water; 3. Food is rapidly generated in such enclosures; 4. The density of the water in the ponds is not materially affected by rains, or leaching from the banks; 5. Ponds are readily excavated in salt-marsh lands, and can in all probability be used for fattening and growing Ostrea virginica for market just as successfully as Ostrea edulis and angulata are grown by a similar method on the coasts of France. Pond-culture, where there are salt-marshes adjoining arms of the sea the waters of which have a density below 1.020, can doubtless be carried on profitably in connection with the intelligent use of simple, cheap collecting-apparatus placed in both open and confined waters to catch a 'set' of spat, which can then be transferred to ponds or open beds. The methods of spawn-taking and pond-culture introduced by the writer are inexpensive and very simple, and can be understood and conducted by any person of ordinary intelligence, and are fully described in papers already published, or in course of publication, by the U. S. fish-commission, under the auspices of which he has been enabled to carry out his investigations. The experimental difficulties have been overcome. It remains for practical men to avail themselves of whatever of value has been determined by these experiments. There are thousands of acres of salt-marsh land along the eastern coast of the United States, which, with proper preparation, might be made to yield a living to a large number of persons, and which is now not productive of any thing except mosquitoes and malaria.

Pond-culture has one other decided advantage over culture in the open water; namely, that it is possible to effectually exclude from the artificial enclosures certain enemies of the oyster, such as whelks and star-fishes.

J. A. Ryder.

THE EXPLOSION OF THE RIVERDALE.

The boiler of the steamer Riverdale exploded on the 28th of August, a few minutes after the boat had left her wharf at New York, and started for her destination on the Hudson River above the city. Several lives were lost, and the boat itself was sunk in sixty feet of water. The boiler was raised, and placed upon the wharf near the Delamater iron-works; and the boat, a worthless wreck, was towed to the New-Jersey side of the river.

The steamer had two 'flue-boilers' 25 feet (7.6 m.) long, 6 feet 4 inches (1.93 m.) in diameter, containing four 'direct' flues 14 inches (0.36 m.) in diameter, two of 9 inches (0.23 m.) diameter, and five 'return' flues of 11½ inches (0.28 m.) diameter. The shell was of no. 3 iron, and the area of heating-surface was 676 square feet (63 sq. m.). The iron was of good quality, and was in good condition throughout, except along the bottom, where it gave way. The form, proportions, and workmanship of the boiler were good. The builders, Messrs. Fletcher & Harrison of New York, were among the most reputable constructors of engines and boilers in that city, and were noted for doing good work.

On examination, it was found that the bottom was corroded along its whole length, and had been patched in a number of places where the iron had become dangerously thin, and that in some places the sheets were reduced to one-fourth their original thickness. The shell had been repeatedly patched, and five 'soft patches' were found on the girth-seams. The rupture seems to have started in the thin parts of the bottom, and to have followed the weakened girth-seams quite around, and divided the mass into two parts of nearly equal size, tearing the middle sheet out of the shell entirely.

A coroner's jury made an inspection, examined such witnesses as could be found and such experts as could be induced to testify, and rendered a verdict to the effect that the boiler ruptured in consequence of the weakness of the sheets on the bottom of the shell, which were unable to sustain the working pressure allowed by the U. S. inspector; which weakness had been produced by corrosion on the interior, due to the action of the feed-water. It was further asserted, that the boiler was tested in June up to a pressure of 62 pounds (5 atmos. abs.), and burst ten weeks later under a pressure of but 32 pounds (3 atmos.), in consequence of the neglect of the inspector to observe its condition at the time of testing it. The engine-driver and the inspector were censured by a vote which was not unanimous. The jury expressed the opinion that the present law is not sufficiently explicit and mandatory, and that the use of the test by hydrostatic pressure is insufficient to detect and reveal such defects as here existed.

The inspector acknowledged that he did not try the strength of the boiler with the hammer, as is now usual in all thorough examinations by competent engineers, but merely looked it over; and that at previous inspections he had not entered the boiler, but had only looked in at the manhole. The evidence of the most superficial and inefficient 'inspection' was conclusive; and the fact that proper inspection would have revealed the dangerous condition of the boiler was equally well proven. The so-called 'inspection' was a farce; and the inspector, in a spirit of indifference or indolence, took the chances of an explosion.

The exploded boiler weighed 27,000 pounds (12,247 kilos), and contained 25,000 pounds (11,340 kilos) of water. The explosion was not remarkably violent, but was what old engineers are accustomed to call a 'burst' rather than an explosion. The consequences were, however, sufficiently serious. The energy producing the effects seen in the case of a true explosion may be imagined, when the amount of heat-energy stored up in such a boiler is calculated. The quantity of heat transformed into mechanical energy by a mass of water and of steam of such magnitude, set free, and expanding down to the pressure and temperature of the atmosphere, from the pressure and temperature at which it existed in the boiler of the Riverdale, would amount to above 1,500,000,000 foot-pounds (over 200,000,000 kilogrammetres). This would be sufficient to throw the boiler and its contents, were the heat all utilized, as in a perfect steam-engine, five miles high. This may give some faint idea of the enormous forces at work, and the tremendous energy stored in a steam-boiler, even where the pressure of the steam is very low, as it was in this case.

It will be concluded, from what has been above stated, that a steam-boiler of the most ordinary and least dangerous type has stored within it an inconceivable amount of available energy in the form of heat, which may be at any moment transformed, in part, into mechanical energy with terribly destructive results, both to life and property; that this powerful agent for good or for evil can only be safely utilized when the utmost care, intelligence, and skill, are employed in its application, and in the preservation of the vessel in which it is enclosed; that the present code of law relating to the care, management, and inspection of steam-boilers, is entirely inadequate to insure safety; that the inspection of steam-boilers, as at present practised by the employees of the government, is not only liable to be inefficient, but is likely to prove worse than none, as it gives to the owner, and perhaps often to the man in charge, of the boiler, a feeling of security which is entirely without basis in fact, and which may therefore cause the neglect of that watchfulness which might otherwise prevent accident; that simple pressure produced by the test-pump, as now provided for by the law, is not a sufficiently effective method of detecting weakness in the boiler, or to be relied upon to the exclusion of other better and well-known methods of test.

The fact that the hydrostatic test is not conclusive as to the safety of a boiler has long been well known and admitted among intelligent engineers. The steam ferryboat Westfield met with precisely such an accident a dozen years ago; and it was shown at the coroner's inquest, at which the writer assisted that official in the examination of his expert witnesses, that the boiler had been inspected, and had been tested, but a few weeks before, by the U.S. inspector, who applied a pressure considerably in excess of that at which the explosion took place. The cause of the accident, by which a large number of people lost their lives, was precisely that which caused the explosion of the Riverdale's boiler, and the method of rupture was the same. In either case, proper methods of inspection would have saved the lives of the sufferers.

It is undoubtedly true, that many of the inspectors are conscientious, experienced, skilful, and painstaking men, and do their duty in spite of the defects of the existing law; but it is also true that now and then a careless or incompetent inspector will neglect the simplest details of his work, and that we must expect occasional repetition of this sad experience, until the law is intelligently framed, and so administered that the passing of a defective boiler by the inspector shall become as nearly as possible an impossibility.

Robert H. Thurston.

Hoboken, Sept. 23, 1883.

THE AMERICAN SOCIETY OF MICROSCOPISTS.

The sixth annual meeting was held this year in Chicago, Aug. 7–11. The usual number of members was present, and the meeting was full of interest from the beginning to the end. The forenoon session of Tuesday was given to organization, and the report of the president on the official action of the executive officers for the year. At the afternoon session, papers were read as follows. Microscopical examination of seminal stains on cloth, by F. M. Hamlin. After pointing out the defects of Koblanck's method, that usually given in the manuals, he explained his own, which he had found eminently successful. It is in brief as follows. "1. If the stain to be examined is upon any thin cotton, linen, silk, or woollen fabric, cut out a piece about one-eighth inch square, lay it upon a slide previously moistened with a drop of water, and let it soak for half an hour or so; . . . then with a pair of needles unravel or fray out the threads at the corners, put on the glass cover, press it down firmly, and submit to the microscope. 2. If the fabric is of such a thickness or nature that it cannot be examined as above, fold it through the centre of the stain, and with a sharp knife shave off the projecting edge thus made, catching upon a slide moistened with water the particles removed. After soaking a few minutes, say five to ten, the powdery mass will sink down through the water, and rest upon the slide. The cover-glass may now be put on, and the preparation examined."

College microscopical societies, by Sarah F. Whiting. The author discussed, first, the question 'What use can a microscopical society subserve?' second, 'How can it be made a success?' Such a society, in its range of topics, can take in almost all the physical and social sciences; and an enthusiasm created in it will help many of the departments of college-work. The society welcomes the incoming classes, and affords an opportunity for a change to those accustomed to years of dry drill in the mathematics and languages of the preparatory schools. It opens their eyes to the perfections of nature, awakens in them a curiosity, and stimulates interest in all the scientific studies of the college course. There are interesting subjects of microscopical investigation, carried on in society, which do not come under any department of college instruction. The live college microscopical society will not only awaken interest in students and teachers, but will attract the attention of the authorities who control the funds, and the community generally. The conditions of success in such a society are just what they are in every other scientific society the object of which is not alone investigation, but instruction of its members and others. There must be desirable members, those who are willing to work: all must have something to do. "The freshmen, by their exclaiming, fan the flame of enthusiasm, and, before they can do any thing alone with the microscope, can serve the society on the lamp committee." There should be a class in microscopical technology, apparatus, a library, and especially the current scientific journals.

Cataloguing, labelling, and storing microscopical preparations, by Simon H. Gage. This paper pointed out the advantages of properly cataloguing, etc., one's microscopical preparations, and then gave in detail the course found to be successful by the author. "The catalogue should indicate all that is known of a specimen at the time of its preparation, and all the processes by which it is treated. It is only by the possession of such a complete knowledge of the entire history of a preparation that one is able to judge with certainty of the comparative excellence of methods." The card method is advocated. "The cards are postal-card size, and each preparation has its own card. . . . These may be arranged alphabetically; and, as new preparations are made, new cards may be added in their proper order, while those of destroyed or discarded preparations may be removed without in any way marring the catalogue. Finally, the cards may be kept in a neat box which occupies but little more space than a manuscript book." The cabinet should allow the slides to be flat, exclude dust and light. Each slide should have a separate compartment, numbered to agree with the slide. The floor of the compartment should be beveled at the end, so as to facilitate removal; and the drawers of the cabinet should be independent, but so close together that slides will not fall out when tipped; and each should be numbered with Roman letters.

The president, Albert McCalla, delivered his annual address, Tuesday evening, in Weber music-hall. His theme was 'Verification of microscopical observation.' Referring to the scientific spirit and a common bond of the society's organization, he said, "In this intensely practical age of ours, we are in danger of forgetting that the true aim of science is simply the pursuit of truth, and that the mighty benefits, the invaluable and almost countless gifts, of wealth and ease and safety, which result from scientific discovery, and which so greatly bless the world to-day, will result most surely when science has an eye single to the search for simple truth, — truth that to the practical world seems often abstract and unimportant. . . . We are not all botanists, not all zoölogists, nor all students of lithology; yet we have a well-defined common ground. We are all deeply interested in the physics of the microscope and in the methods of its use; and, in order to be skilled in that department of investigation we have severally chosen, we must be more or less fully practical in microscopical work in many fields." To prove that "only as theories are submitted to repeated and varied forms of verification is error eliminated and final truth obtained," numerous facts were cited from the history of scientific progress; after which, the means of verification of microscopical observation were discussed. These are repetition of observation, use of the camera lucida, photomicrography, media and reagents, improved lenses and apparatus, and a better knowledge of optics.

Wednesday forenoon was devoted to papers on bacteria. T. J. Burrill read a paper on preparing and mounting bacteria. He stated that the elements of successful staining are as follows: "1. The organisms should be decidedly and conspicuously stained; 2. The general mass of embedding-material should be left unstained, or so different in color that the organism can be distinctly seen; 3. There should be no granular or other precipitations from the staining-material; 4. The color should be suitable for the purposes required, and permanent if the object is to be mounted; 5. The process should be as simple as possible, and free from manipulative difficulties. . . . Except for a few special results, aniline dyes are by far the most serviceable in staining bacteria. However, no one staining-material, nor any single method of procedure, can be made to answer well the requirements for all kinds of bacteria."

Dr. H. J. Detmers presented some conclusions reached by himself while studying the diseases of cattle in Texas. Bacteria he regarded as unquestionably the cause of certain fevers. Under certain conditions, all bacteria become pathogenetic; but these conditions are not yet fully understood.

Dr. George E. Fell read a paper on the clinical advantages of ozone, and its effects on the micro-organisms of infusions. After giving the favorable results of the use of ozone by Dr. F. W. Bartlett in scarlet-fever, diphtheria, whooping-cough, typhoid-fever, etc., he gave in tabular form the results of a series of experiments by himself, — experiments in which bacteria, and other forms indigenous in infusions, were subjected to the influence of air charged with ozone.

Following the discussion on the three preceding papers, Dr. G. E. Blackham presented the report of committee on oculars. The report recommends naming oculars, like objectives, by their equivalent focal lengths in English inches. For the tubes of oculars the standard medium size, 1.25 inch is recommended, with the alternatives of 1 inch and 1.35 inch for those who wish smaller or larger tubes; also for the upper tube of the ocular .75 inch, and, for sub-stage tube, 1.50 inch. The purpose of the society is to secure uniformity in these sizes, so that apparatus of different makers shall be interchangeable, as objectives have been since the adoption of the 'society screw.'

The first paper in the afternoon was a critical study of the action of a diamond in ruling lines on glass, by Prof. William A. Rogers. The author stated his theory relating to the method which Nobert may possibly have employed in the production of his plates briefly thus: "The lines composing Nobert's finest bands are produced by a single crystal of the ruling-diamond, whose ruling qualities improve with use. . . . When a diamond is ground to a knife-edge, this edge is still made up of separate crystals, though we may not be able to see them; and a perfect line is obtained only when the ruling is done by a single crystal. When a good knife-edge has been obtained, the preparation for ruling consists in finding a good crystal. Occasionally excellent ruling-crystals are obtained by splitting a diamond in the direction of one or more of the twenty-four cleavage planes which are found in a perfectly formed crystal. A ruling-point formed in this way is, however, very easily broken, and soon wears out. Experience has shown that the best results are obtained by choosing a crystal having one glazed surface, and splitting off the opposite face. By grinding this split face, a knife-edge is formed against the natural face of the diamond, which will remain in good condition for a long time. When a ruling-crystal has been found which will produce moderately heavy lines of the finest quality, it is at first generally too sharp for ruling lines finer than 20,000 or 30,000 to the inch, even with the lightest possible pressure of the surface of the glass. But gradually the edges of this cutting-crystal wear away by use, until at last this particular crystal takes the form of a true knife-edge which is parallel with the line of motion of the ruling-slide: in other words, when a diamond has been so adjusted as to yield lines of the best character, its ruling-qualities improve with use. If Nobert had any so-called 'secret,' I believe this to have been its substance.

"The problem of fine ruling consists of two parts, — first, in tracing lines of varying degrees of fineness; and, second, in making the interlinear spaces equal. The latter part of the problem is purely mechanical, and presents no difficulties which cannot be overcome by mechanical skill. It will be the aim of the present paper to describe the more marked characteristics of lines of good quality ruled upon glass. . . . A perfect line is densely black, with at least one edge sharply defined. Both edges are perfectly smooth. Add to these characteristics a rich black gloss, and you have a picture of the coarser lines of a perfect Nobert plate. In the study of the action of a diamond in producing a breaking fracture in glass, the microscope seems to be of little service; but we can call it to our aid in the study of its action in ruling smooth lines. One would naturally suppose that a line of the best quality would be produced by the stoppage of the light under which it is viewed by the opaque groove which is cut by the ruling-diamond. Without doubt, this is the way in which lines are generally formed; but it is not the only way in which they can be produced. An examination under the microscope will reveal the fact, that in some instances, at least, a portion of the glass is actually removed from the groove cut by the diamond; and that the minute particles of glass thus removed are sometimes laid up in windrows beside the real line, as a plough turns up a furrow of soil. . . . The particles of glass removed take four characteristic forms: (*a*) They appear as chips scattered over the surface of the glass; (*b*) They appear as particles so minute, that when laid upon a windrow, and forming an apparent line, they cannot be separated under the microscope; (*c*) They take the form of filaments when the glass is sufficiently tough for them to be maintained unbroken; (*d*) They take a circular form. . . . It must not, however, be supposed that lines of the best quality always present the appearance described above." These characteristic results were illustrated by plates, with the fragments and fibres in place. The author also referred to Mr. Fasoldt's claim, that he has succeeded in ruling lines one million to the inch. He thinks the limit just a trifle too high; but, if reduced one-half, he is by no means sure but that it may be reached.

Following this was a paper by A. H. Chester, describing a new method of dry mounting, in which the cover-glass is easily removable. The object is fastened to the slide in the usual way, and a tin cell built up about it sufficiently high for the cover to clear the object; then a ring of larger bore is cemented on, making a flange to receive cover. The latter ring, having been punched out of tin foil by a gun-wad punch, and put in place with the smaller hole uppermost, makes a groove above the cover, into which a spring-brass ring is put, holding the cover in place. The advantages of this method are many, — the objects may be easily viewed uncovered; dust or moisture accumulating in the cell may be removed; the mounting is quickly done, etc.

In the evening session, Mr. W. H. Walmsley read a paper giving the latest and best results and methods, by himself and others, in the art of photomicrography. The photographs in illustration were exhibited by L. D. McIntosh by means of his solar microscope with ether oxygen light.

Following this was a short paper by D. S. Kellicott, giving an account of certain stalked infusoria found in the crayfish. Two species, believed to be peculiar to the gill-chambers, were described. One of these is new to science, and was named Cothurnia variabilis. The well-marked varieties seem to be due to situation; i.e., those on the hairs of the lining-membrane are relatively longer, with a spine at the upper edge of the aperture of the lorica, but without a spine on the ventricose front of the same, while a stouter variety, situated on the membrane itself, has a spine in front, but none on the edge of the aperture. A third variety occurs on the gills: it also has a spine on the ventricose part of the shell, but the aperture is horizontal instead of vertical. They are so abundant as to encumber the gills of the host, rendering them brown to the eye. An Epistylis from the same host was named E. Niagarae: it is close to E. balanorum, a marine form. The same writer, at another session, described Cothurnia lata n. s., found on Diaptomus, and also gave a general account of two internal parasites of the crayfish.

The first paper Thursday morning was on the effects of division of the vagi on the muscles of the heart, by A. M. Bleile. The object of the paper was the demonstration of nutritive or trophic nerves for the heart, and was a continuation of work reported in the Proceedings of the society last year.

Following this, T. S. Up de Graff described certain fresh-water worms. One, a rotifer, is new: it was named Brachionus Gleasonii. Independent of the spines, its length is 0.145 inch, the front of the carapace without spines. The posterior edge bears five curved spines: there is one, also, on the dorsal part of the shell, — a peculiar feature.

The remainder of the session was occupied by short papers, by Francis Wolle, on fresh-water algae, and one by John Kruttschnitt on ferns and their development.

In the afternoon the session was opened by a report upon a standard centimetre, prepared by the U. S. bureau of weights and measures, by W. A. Rogers. The lines of the centimetre are ruled on a plate of platinum-iridium soldered to brass with silver. The report describes the plate, and compares its divisions with a standard. The original basis of this unit is a metre upon copper, prepared for Professor Rogers by Professor Tresca of the Conservatoire des arts et métiers at Paris. The report concludes thus: —

1. That the centimetre *A*, measured by the middle defining line, is exactly a hundredth part of the metre des archives reduced to sixty degrees Fahrenheit. It can therefore be safely adopted as the unit in all measures with low-power objectives.

2. That the second millimetre of the scale is exactly a thousandth part of the metre des archives when at the same temperature.

The centimetre is now the property of the society; it having been tendered to it by the national committee on micrometry, and accepted and adopted as a standard or basis for future studies and discussions in micrometry. The scale is in the hands of Dr. George E. Fell. A committee was appointed for securing copies on glass. The rules for its control and use will soon be published.

After this report, Dr. George E. Blackham read a communication on the relation of aperture to amplification in the selection of a series of microscopic objectives. The author showed that amplification is not the only element which enters into the problem of rendering visible minute details, but the aperture of the objective forms another element. Working, then, on the general lines laid down, he had selected as a set of powers, sufficient for all the work of any microscopist, the following: —

One 4-inch	objective	of	0.10 n.a.	= 12°	an angle, nearly.
" 1 "	"	"	0.26 n.a.	= 30°	" " "
" $\frac{1}{6}$ "	"	"	.94 n.a.	= 140°	" " "
" $\frac{1}{8}$ "	"	"	1.42 n.a.		

"The first two to be dry-working objectives, without cover-correction; the third to be dry-working, with cover-correction; and the fourth to be a homogeneous immersion objective, with cover-correction; and all to be of the highest possible grade of workmanship. The stand should have a tube of such length that standard distance of ten inches from the front surface of objective to diaphragm of eye-piece can be obtained on it, and to be furnished with six eye-pieces; viz., 2-inch, 1-inch, and $\frac{3}{4}$-inch Huyghenian, and $\frac{1}{2}$-inch, $\frac{1}{3}$-inch, and $\frac{1}{4}$-inch solid."

In the evening the annual *soirée* took place, in connection with the State microscopical society of Illinois, at the Calumet club-house. There were two hundred and fifty microscopes on the tables. A great variety of objects were shown to a party of five hundred guests of the club.

There were a number of reports and papers to be disposed of on Friday, the society adjourning at five P.M.

The first paper was by Dr. W. T. Belfield, on the detection of adulteration in lard. Photographs representing crystals of pure and adulterated lard were exhibited. Those of the former are long, thin plates, with beveled ends, while the crystals of tallow are plume-shaped, resembling somewhat an ostrich feather.

Dr. V. S. Clevinger presented a paper on the pathology of the brain.

Dr. Thomas Taylor's paper, on internal parasites in the domestic fowl, was read. The parasites referred to were a mite from the lungs, another mite in the cellular tissue, and an encysted nematoid from the crop.

A paper on the termination of the nerves in the kidneys was presented by M. L. Holbrook. The author's method may be stated thus: "The fresh kidneys, as well as those preserved in chromic-acid solutions, were frozen in the freezing-microtome of Dr. Taylor, and the sections allowed to remain in the gold solution for varying periods of time, from forty minutes to several days. When removed, they were carefully washed in distilled water, and placed in a strong formic acid of a specific gravity of a hundred and twenty degrees for from five to eight minutes, or in a twenty-five-per-cent solution of the same for hours and even days. Sometimes I obtained very good specimens by placing the sections first in a dilute twenty-five-per-cent solution of formic acid for twenty-four hours, and afterward staining them with chloride of gold until they reached the color desired. . . . The nerves supplying the kidneys are mainly of the non-medullated variety. They accompany the larger arteries of this organ, either in bundles, or in flat, expanded layers; and the latter features I found more common than the former. Sometimes an artery would be found encircled by a network of non-medullated nerves in a bewildering number. Hundreds of such nucleated bundles of fibres could be traced around, above, and below an artery, freely branching, bifurcating, and supplying all the neighboring formations with a large number of delicate fibrillae. . . . The bundles of nerve-fibres give off delicate ramules to the afferent vessels by which they enter the tuft; and here they produce a delicate plexus spun around its capillaries. It was impossible to decide where the ultimate fibrillae branch in the capillaries of the tuft. . . . Sometimes I obtained specimens in which it seemed as if the ultimate fibrillae branched beneath the covering, flat epithelia in the delicate connective tissue between the convolutions of the capillaries. . . . In perfect specimens there is no difficulty in satisfying one's self of the fact that every tubule is encircled by a plexus of non-medullated nerve-fibres, coursing either in the immediate vicinity of the tubule, in the interstitial connective tissue, or within the dense layer subjacent to the epithelia, known as the *membrana propria*, or even with the layer along the feet of the epithelia themselves."

Short papers were read by Dr. Salmon Hudson, on the yeast-plant; by J. M. Mansfield, on division of labor among microscopists; by Dr. L. M. Eastman, on egg-like bodies in the liver of the rabbit; by Dr. George E. Fell, on a peculiarity in the structure of the human spermatozoon. Dr. Lester Curtis made some observations on vessels of the spinal cord of the cat; and Dr. F. M. Hamlin, on mounting foraminifera. New apparatus was described as follows: new microscope-stand with concentric movements, by J. D. Cox; new modification of the Spitzka microtome, by V. S. Clevinger; and a new binocular arrangement, by Edward Bausch.

The next annual meeting will be held at Rochester, N.Y., in August, 1884.

The officers for the present year are: president, Hon. Jacob D. Cox; vice-presidents, William A. Rogers, T. J. Burrill; secretary, D. S. Kellicott; treasurer, George E. Fell; executive committee, Albert H. Chester, William Humphreys, and H. A. Johnson.

Heights in feet, Depths in fathoms

THE JAVA UPHEAVAL.[1]

The details which have reached us during the past week, of the terrible seismical manifestation at Java, prove it to be one of the most disastrous on record. Probably, moreover, it is the greatest phenomenon in physical geography which has occurred during at least the historical period, in the same space of time. The accompanying sketch-map will afford some idea of the extent and nature of the change which has taken place, and the character of the sea-bed and the land in the region affected.

The volcanic island of Krakatoa lies about the

[1] Taken from *Nature*, Sept. 6.

middle of the north part of the passage between Java and Sumatra, a passage which has formed an important commercial route. The strait is about seventy miles long and sixty broad at the south-west end, narrowing to thirteen miles at the north-east end. The island, seven miles long by five broad, lay about thirty miles from the coast of Java; and northwards the strait contracts like a funnel, the two coasts in that direction approaching very near to each other. A few weeks ago, as we intimated at the time, the volcano on the island began to manifest renewed activity. The whole region is volcanic; Java itself having at least sixteen active volcanoes, while many others can only be regarded as quiescent, not extinct. Various parts of the island have been frequently devastated by volcanic outbursts, one of the most disastrous of these having proceeded from a volcano which was regarded as having been long extinct. The present outburst in Krakatoa seems to have reached a crisis on the night of Aug. 26. The detonations were heard as far as Soeràkarta; and ashes fell at Cheribon, about 250 miles eastwards on the north coast of Java. The whole sky over western Java was darkened with ashes; and, when investigation became possible, it was found that the most wide-spread disaster had occurred. The greater part of the district of North Bantam has been destroyed, partly by the ashes which fell, and partly by an enormous wave generated by the wide-spread volcanic disturbance in the bed of the strait. The town of Anjer, and other towns on the coast, have been overwhelmed and swept away; and the loss of life is estimated at 100,000. The island of Krakatoa itself, estimated to contain 8,000,000,000 cubic yards of material, seems to have been shattered, and sunk beneath the waters; while sixteen volcanic craters have appeared above the sea between the site of that island and Sibisi Island, where the sea is comparatively shallow. The Soengepan volcano has split into five; and it is stated that an extensive plain of 'volcanic stone' has been formed in the sea, near Lampong, Sumatra, probably at a part of the coast dotted with small islands. A vessel near the site of the eruption had its deck covered with ashes eighteen inches deep, and passed masses of pumice-stone seven feet in depth. The wave reached the coast of Java on the morning of the 27th, and, thirty metres high, swept the coast between Merak and Tjiringin, totally destroying Anjer, Merak, and Tjiringin. Five miles of the coast of Sumatra seem to have been swept by the wave, and many lives lost. At Tanjong Priok, fifty-eight miles distant from Krakatoa, a sea seven feet and a half higher than the ordinary highest level suddenly rushed in, and overwhelmed the place. Immediately afterwards it as suddenly sank ten feet and a half below the high-water mark, the effect being most destructive. We shall probably hear more of this wave, as doubtless it was a branch of it which made its way across the Pacific, and that with such rapidity that on the 27th it reached San Francisco harbor, and continued to come in at intervals of twenty minutes, rising to a height of one foot for several days. The great wave generated on May 10, 1877, by the earthquake at Iquique, on the coast of Peru, spread over the Pacific as far north as the Sandwich Islands, and south to New Zealand and Australia; while that at Arica, on Aug. 13 and 14, 1869, extended right across the Pacific to Yokohama (*Nature*, vol. i. p. 54). It is misleading to speak of such waves as tidal: they are evidently due to powerful, extensive, and sudden disturbances of the ocean-bed, and are frequently felt in the Pacific when no earthquake has been experienced anywhere, though doubtless due to commotions somewhere in the depths of ocean. So far, these are all the facts that are known in connection with this last stupendous outburst of volcanic energy. It has altered the entire physical geography of the region, and the condition of the ocean-bed. The existing charts of the strait, with their careful soundings, are useless for purposes of navigation; and, when quiescence is restored, a new series of soundings will be necessary. Doubtless the results of the outbreak will receive minute attention at the hands of the Dutch government; and, when all the data are collected, they will form valuable material for the study of the physical geographer.

LETTERS TO THE EDITOR.

Humblebees vs. field-mice.

In SCIENCE of Sept. 7 the vice-president of section F (biology), in his address of Aug. 15, referring to the aid given by humblebees in fertilizing Trifolium pratense, is reported as saying, "Bumblebees prefer to raise their colonies in old nests of meadow-mice. I mentioned in my last report, that it had been suggested that we should not keep many cats, nor allow hawks, foxes, or dogs to catch these mice; for they make nests which are quite necessary for the bumblebees, which help fertilize our red clover, and thereby largely increase the yield of seed."

I would beg leave to differ from the author of the suggestion referred to, on the ground, that, if carried out, the effect produced would be apt to be quite the contrary of that intended. As field-mice prey upon the nests and combs of the humblebees, acting as a great check to their increase in numbers, the greater the precautions taken to prevent the killing of the mice, the greater would be the tendency towards the extermination of the humblebee, and therefore the less would be the yield of seed, resulting from the lack of aid rendered by these insects in fertilizing the red clover.

In support of my objection, I would refer to Darwin's Origin of species, sixth edition, third chapter, where, under the head of "Complex relations of all animals and plants to each other in the struggle for existence," he says, "The number of humblebees in any district depends in a great measure on the number of field-mice, which destroy their combs and nests; and Col. Newman, who has long attended to the habits of humblebees, believes that 'more than two-thirds of them are thus destroyed all over England.'" E. NUGENT.

Pottstown, Penn., Sept. 15, 1883.

The influence of winds upon tree-growth.

I observe that in the vicinity of Cambridge and Boston, wherever the common New-England elms stand in a moderately isolated site, and one exposed to the wind, they lean, in a large majority of cases, trunk and all, to the south-east. This is true, also, to a less extent, of maples; but the oak, ash, poplar, and pine stand sturdily erect. I believe the leaning of the elastic-fibred elms is due to the prevailing winds, which are from the west and north-west, these winds being also the strongest and coldest. At the office of the U. S. signal-service in Boston, observations are taken three times a day. In 1882, out of 1,095 observations taken, 298 showed the wind to be in the west, and 225 showed it to be in the north-west: in other words, about half (or forty-seven per cent) of the observations showed the wind to be somewhere between west and north-west. For the other five years the record is as follows: —

1877.	1878.	1879.	1880.	1881.
247 W.	229 W.	273 W.	301 W.	278 W.
169 N.W.	231 N.W.	257 N.W.	153 N.W.	175 N.W.

So much for the prevailing direction of the wind. There seems to be no other cause than this, to which we can assign the phenomenon of growth in question. All the many exceptions to the rule are to be explained, doubtless, by local causes, — shelter, neighborhood of other trees, and other more occult conditions of fibre. The works on forestry and botany seem not to notice the fact of asymmetry in tree-growth. It is only a repetition, on a larger scale, of the graceful deviation from monotonous symmetry which characterizes all leaf and branch structure.

W. S. KENNEDY.

Importance of lime-juice in the pemmican for arctic expeditions.

The recent failure to relieve the party under Lieut. A. W. Greely at Lady Franklin Bay leads us to recur to the repeated difficulties which have marked the history of former arctic expeditions. We have re-examined the accounts of the English expedition of the Alert and the Discovery, under Nares and Stephenson, which left England, May 29, 1875. It was the first English arctic expedition which had orders to endeavor to reach the North Pole. It had the advantage of the advice of experienced arctic navigators, its commander Nares having been a member of several such expeditions.

Thus it surprises the reader, that more thorough precautions were not made against the scurvy. The *London quarterly review* for January, 1877, has the fullest account of the ravages committed by that disease with the sledge-parties sent out by Nares. Of the sledge-party under Commander Parr it says,—

"Of seventeen of the finest men of the navy, who composed the original party, but five were (on return) able to walk alongside. One was dead, and the remainder in the last extremity of illness."

It gives a minute account of the prostration by scurvy of the two other sledge-parties, — one under Commander Beaumont, and one under Commander Aldrich. Concerning the latter, the *Review* says, —

"To quote from the journal of Commander Aldrich, who led the western division, would be to repeat the same dreadful details. The party broke down, and were supported by the same pluck, and brought back alive — that is all one can say — by the help of God and the same determined courage. Surely, nothing finer was ever recorded than this advance of three sledges, — one to the north, another to the east, a third to the west, — laden down with sick and dying men, in obedience to an order to do their best, each in their separate direction. It is the old story, — too common in English annals, — the organization broke down, and individual heroism stepped in to save the honor of the day. But at what a cost!"

All this was because the parties had no lime-juice. And Capt. Nares, "with a chivalry and candor which do him honor, whether he has failed in judgment or not, declared that such was the fact, and that the omission was made by his orders and on his responsibility." He said, —

"Acting on my lights and experience at the time, I followed the example of such men as M'Clintock, Richards, Mechan, and McClure, of the Investigator, and started off our sledges with as nearly as possible the same rations as had proved fairly successful on all previous occasions; that is, without lime-juice for issue as a ration, a small quantity for use as a medicine being carried by the sledges, which were not expected to be able to obtain game. . . . Up to the middle of May the lime-juice remains as solid as a rock. No sledge-party employed in the arctic regions in the cold month of April has ever been able to issue a regular ration of lime-juice. In addition to the extra weight to be dragged, that its carriage would entail, there is the even more serious consideration of the time necessary in order to melt sufficient snow."

He added, —

"Of course, hereafter, lime-juice in some shape or other must be carried in all sledging journeys; and we earnestly *trust that some means will be found to make it in a lozenge*, for, as a fluid, there is, and will always be, extreme difficulty in using it in cold weather, unless arctic travelling is considerably curtailed."

The *Quarterly review*, in quoting these manly remarks of Capt. Nares at Guildhall, says, —

"Even if it should be found that Sir George failed in judgment in this matter, he has in our opinion shown the finer form of fitness for command, in his readiness to assume the responsibility of his acts."

His frankness and manliness in assuming the whole blame to himself have evidently, in great measure, disarmed criticism.

But this brings us to the main object in this letter; and that is, to recur to the remedies which this story has suggested. If lozenges of lime-juice in a shape for arctic exploration have not been manufactured, they certainly can at least now be found at the druggists in a shape to be used as troches for colds.

But the efficient remedy is to have pemmican made which is permeated with lime-juice, as recommended in the 'Report of the surgeon-general of the navy for 1880' (see p. 356). Gen. P. S. Wales said, —

"The indispensable necessity of lime-juice in the sledging-parties, and the difficulties of carrying it, and preparing it for use, induced me to suggest the propriety of combining the juice and pemmican in the proportion of one ounce to the pound of the latter. The pemmican is greatly improved in taste and flavor, and will, I believe, be more assimilable. This is an important modification, as there are persons who cannot eat the ordinary article."

The article was prepared as proposed, and tried in Washington, and pronounced to be very palatable.

Gen. George H. Thomas, in preparing for one of his battles, issued a general order, enjoining upon his whole army strict attention to minutiae, saying that "the loss of a battle might be due to one missing linchpin."

In recurring to this recommendation from the office of the surgeon-general of the navy, we have thought that it may be considered opportune, when the minds of many are now turned upon the arctic expeditions. We think that recommendation was followed, so far as the preparations of the Jeannette and the Rodgers were concerned; but, alas! they never got so far as to turn their attention to fitting out explorations with sledge-parties.

BENJAMIN ALVORD.

Rensselaeria from the Hamilton group of Pennsylvania.

Will you kindly afford me a small space to correct an error in your report of the discussion which followed the reading of my paper at Minneapolis? On p. 327 of your issue for Sept. 7 occur the following sentences: —

"The differences between them [the fossils exhibited and the Oriskany species of Rensselaeria] were slight, though well marked. Professor Hall described some of these differences, and Mr. Claypole acknowledged that a certain V-shaped groove was wanting in his specimens. Professor Hall thought that possibly the fossils should be referred to Amphigenia, which had many similarities to Rensselaeria."

The V-shaped groove in question is one of the generic marks of Amphigenia; and its absence, therefore, was urged by me as excluding the fossils from that genus, and inferentially as a strong argument in favor of placing them in Rensselaeria.

As the above-mentioned error places me (and I think Professor Hall also) in false positions, and involves a grave mistake in paleontology, I am induced to ask your insertion of this correction, which I have submitted to Professor Hall for his approval.

I ought to add that the suggestion of Amphigenia by Professor Hall was only the result of a momentary impression on the first sight of the fossil, and one which he immediately withdrew, on observing the absence of the V-shaped groove above alluded to.

E. W. Claypole.

Aurora.

The auroral display here to-night was unusually brilliant. I observed it first at 7.04 p.m. At this time a low but rather brilliant arch of light spanned the north-eastern horizon, the crest of the arch having an altitude of about 20°. During the next three minutes, the lights rapidly took on the 'streamer' form, gradually shooting upward to a little beyond the zenith, and at this time stretching from east, 10° south, around to west, 15° north, on the horizon. During about two minutes, the waving-curtain aspect was very pronounced in the north-east, after which only striated patches flamed out here and there, moving alternately west and east. These patches all converged toward the zenith, but left with one the impression of being pendulous and very near. The atmosphere appeared very clear, the moon full and bright, the twilight still strong; and there was light enough yet to enable one to read a newspaper, but with difficulty. The streamers, however, lay in sharp contrast against the blue sky, even where the twilight was strongest.

At 7.15 the lights began to die rapidly away, and at 7.50 none were to be seen; but at 8, and again at 8.13, there were distinct but small curtains to be seen in the north-west. At 8.20 there began a magnificent display. Three large curtains formed one above the other, the lowest about 20° above the horizon in the north-west. They drifted gently toward the zenith, swaying and folding just enough, it seemed, to suit the almost imperceptible breeze which was stirring. The lights could be easily seen within 7° of the moon; and yet it cast its shadow on the carpet in a room 13 by 14, where two kerosene-lamps were burning, one of them a no. 1, and the other a no. 2, burner. At 9.10 scarcely a trace of the aurora could be seen. A little later, a very faint diffuse light covered the northern sky to an altitude of about 25°. This soon became striped, and afterwards appeared to move bodily toward the zenith. At 10.20 the lower sky had become a deep blue; and just above it, at an altitude of 30°, a broad arch of bright but uniform light formed across the sky; and above this, extending past the zenith, were similar but much fainter bands. Five minutes later, the bright band unfolded a curtain which dropped in exquisite folds toward the horizon. This lasted less than two minutes, the whole belt of light becoming striated, but leaving a clear space next to the horizon; then followed about five minutes during which the illuminated portion of the sky seemed to be throbbing, and sending out waves of subdued light, which spread southward over the blue vault, dying away before the zenith was reached. This movement soon became more violent; and between 10.40 and 10.45 the lights had more the appearance of flames bursting rapidly from the sky, and spreading to the zenith, where they often turned abruptly toward each other, and met. This appearance continued growing gradually less marked until 12.15 a.m., when there was scarcely a trace of auroral display. At 12.40 a faint arch of diffuse light could be seen in the north, like that already described.

F. H. King.

River Falls, Wis., Sept. 16, 1883.

THOMPSON'S PHILIPP REIS.

Philipp Reis: inventor of the telephone. A biographical sketch, with documentary testimony, translations of the original papers of the inventor, and contemporary publications. By Sylvanus P. Thompson, B.A., D.Sc., professor of experimental physics in University college, Bristol. London, *E. & F. N. Spon*, 1883. 9+182 p., 3 pl. 16°.

The rapid development of the literature of the telephone, and the wide-spread interest in matters relating to it, have rendered the most important details of its history familiar to the general reading public, as well as to the scientific world. The account of the life and labors of Philipp Reis, by Prof. S. P. Thompson, while repeating many of these well-known details, contains some interesting notices of the life and personal characteristics of the inventor, and of the various steps by which he brought his instruments to their final stage. Following the brief biographical sketch, are descriptions of the various forms of apparatus devised by Reis, with numerous illustrations; a statement of what the author terms the inventor's claim; copies of Reis's own publications respecting his invention, and of certain contemporary accounts of it and its operation; with the testimony of persons who witnessed his experiments. An appendix discusses the variable resistance of imperfect contacts, a comparison of Reis's receiver with later instruments, the doctrine of undulatory currents, with some additional notes and references relating to Reis's invention.

Had the efforts of the author been directed to the presentation of these things as matters of history merely, the book might be regarded as a valuable and interesting summary of facts relating to an important invention, and would demand but a brief notice here; but a cursory examination of it is sufficient to show that the author has failed to maintain that judicial attitude of mind which is indispensable to the just and impartial record of historic verities. His book is throughout a labored special pleading, with the attempt to prove that Reis's invention not only anticipated, but actually embodied, the essential features of the present telephonic apparatus. Space will not permit the consideration of all the points which might be criticised, nor is it necessary. A few of the most important are sufficient to illustrate the spirit which pervades the work, and to show how the facts of history are perverted in the endeavor to maintain a false and illogical position.

It has been generally accepted as true, that Reis designed his transmitter to act as a contact-breaker, which should open and close the circuit once for each vibration produced by the sound to be transmitted. The support for this view is found not only in the repeated statements of Reis himself, but also in the construction of the apparatus. Reis says, in his own description of his transmitter (p. 56), "each sound-wave effects an opening and a closing of the current;" and again, in his letter to Mr. Ladd (p. 84), "If a person sing at the station A, in the tube (x) the vibrations of air will pass into the box and move the membrane above; thereby the platina foot (c) of the movable angle will be lifted up and will thus open the stream at every condensation of air in the box. The stream will be re-established at every rarefaction. For this manner the steel axis at station B will be magnetic once for every full vibration."

With these and other most distinct statements of Reis, as to the intention and action of his apparatus, before him, Professor Thompson, nevertheless, asserts that it was never designed to break the circuit. Thus, on p. 14 he says, "Theoretically, the last was no more perfect than the first, and they all embody the same fundamental idea: they only differ in the mechanical means of carrying out to a greater or less degree of perfection the one common principle of imitating the mechanism of the human ear, and applying that mechanism to affect or control a current of electricity by varying the degree of contact at a loose joint in the circuit." And again (p. 132), "Now this operation of varying the degree of pressure in order to vary the resistance of the interruptor or contact-regulator, was distinctly contemplated by Reis." Further, the author maintains that the combination of an adjusting-screw with a spring shows that Reis intended the platinum contact-piece to have a following motion, so as to make a contact with varying pressure. He says on p. 133, "By employing these following-springs, he introduced, in fact the element of *elasticity* into his interruptor; and clearly he introduced it for the very purpose of avoiding abrupt breaking of the contact." If we examine the illustrations of the different forms of the transmitting apparatus, we shall see that this device was employed for a very different purpose. In the earliest form, represented in fig. 1, the screw presses the spring *away* from the membrane, and, when the latter recedes in its vibration, the spring carrying the platinum point is prevented by the screw from following it, — an arrangement that tends to prevent, and was designed to prevent, a following contact, and insures a breaking of the circuit when the distance of the point is properly adjusted. The same is the case with the form of transmitter illustrated in fig. 2. In the form represented in fig. 3, the screw is present, and works against a spring; but the screw passes through a stout and firm piece of metal, and presses the spring which carries the contact-piece forward, that is, toward the membrane, thus giving it a rigid support. The spring serves merely to push back the contact-piece when the screw is reversed, a very simple and common mechanical device for giving motion in opposition to the thrust of a screw. In the lever form, seen in figs. 4 and 5, the

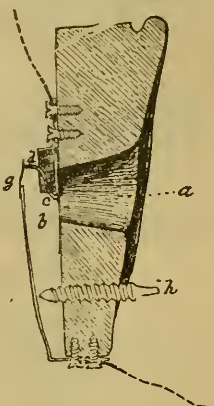


FIG. 1.

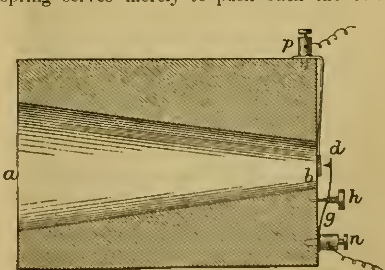


FIG. 2.

screw is arranged in a similar manner, so as to regulate the distance of the contact-piece from the end of the lever most remote from the membrane. In all these instruments the screw acting upon the spring is expressly contrived to facilitate such an adjustment as will insure

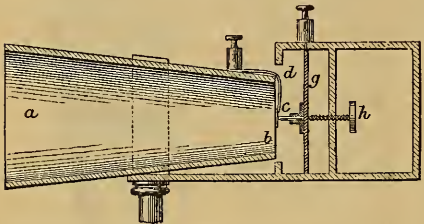


Fig. 3.

the breaking of contact under the impact of the sound-waves. Its function is related to the tension and elasticity of the membrane, to make a pressure so light in any case, that the vibrations should be able, without fail, to separate the contact-pieces.

To say, as Professor Thompson repeatedly does, that Reis employed his mechanism with the express intention of producing a variable current by the change of contact-resistance, and that he consciously and purposely utilized this principle, — at that time hardly recognized anywhere, and of which the practical application was not discovered till several years later, — is a gross misrepresentation, and an utter perversion of the facts. Reis did not know, and could not know, that the strength of a current could be controlled by the varying pressure of the conducting-surfaces between which it passes. Nowhere in his writings, — whether in his description of the instruments, or in the prospectus issued with them, or in his letter to Mr. Ladd, — nor in the article of Professor Böttger and the report of Von Legat, is there the remotest suggestion that the transmitter acted, or was intended to act, otherwise than by breaking the circuit. Nor is any thing of the kind to be found in any of the publications of the day, relating to this matter. With the knowledge which we now possess, of the varying resistance of pressure-contacts, it is indeed easy, by a slight modification, to cause the contact-pieces to vary the current by change of pressure, and thus reproduce the vibration-form with approximate accuracy. But to do this, it is necessary to prevent them from separating so as to break contact and interrupt the current. Such a modification, however slight it may be, totally changes the function of the contact-pieces, and amounts to a radical transformation of the apparatus. It is the very thing Reis studiously sought to prevent.

That Reis speaks of the form of acoustical vibrations, and their graphical representation by a curve, is no proof that he supposed his transmitter to act otherwise than by breaking the circuit. Yet Professor Thompson says (p. 165), "It is certain that Reis did not in any of his writings explicitly name an undulatory current: but it is equally certain that, whether he mentioned it or not, he both used one and intended to use one." Reis nowhere claims that his apparatus realized the normal vibration-form, even in the case of a simple tone; and there is no evidence in all his writings to show that he had ever considered the motions at the receiver to be the same as those of the original sound, except so far as there was a correspondence in period or rate of these motions with those at the transmitter. The idea of causing the motions in the receiver to have the same vibration-form as those in the transmitter originated with Bell, as did the method of securing this correspondence, which is indispensable to the reproduction of spoken words, by the use of an undulatory current. Says Sir William Thomson (*Tel. journ. and electr. rev.*, v. 293), "Mr. Graham Bell conceived the idea — the wholly novel and original idea — of giving continuity to the shocks, and of producing currents which would be in simple proportion to the motion of the air pro-

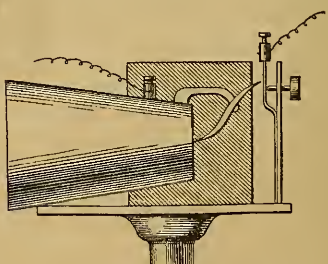


Fig. 4.

duced by the voice, and of reproducing that effect at the remote end of a telegraphic wire." The author of this book will scarcely have the hardihood to assert that his illustrious countryman, one of the greatest masters in electrical science, uttered these words in ignorance of a thing so well known as Reis's telephone.

As a further support to his position, the author lays great stress upon the statement that Reis's apparatus could and did transmit spoken words so as to be understood. As to the fact of speech having been transmitted occasionally, it is doubtless true that some words were recognized, but imperfectly, and with difficulty; and it is true, also, that when imperfectly meeting the conditions set upon it by the inventor, the apparatus, when applied to transmit spoken words, will, with skilful handling, sometimes 'deviate into sense' so far, that an occasional word or short phrase can be made out with effort, by attentive listening with the ear close to it. Professor Böttger, who took an enthusiastic interest in the matter, says that the operators could communicate words with each other, but adds, 'only such, however, as they had already heard frequently.' Of the other experimenters and witnesses whose testimony is given in the book, some were able to understand portions of what was said; others failed. Every one familiar with telephonic experiments knows how easy it is to recognize these familiar phrases by the mere intonation, and how different this is from understanding words not previously known. Is it any thing surprising, that the words of a familiar song should appear to be recognized when the air is heard? Granted that the spoken words were sometimes reproduced so as to be understood, it must also be admitted that the apparatus accomplished this so imperfectly as to be of no practical value. To make it practically efficient required a modification that was in itself a radical change and a distinct invention. That this was also Reis's opinion, will be seen from the extracts given in a subsequent paragraph.

There is good evidence, in the later writings and advertisements of Reis, that he had come to the conclusion that the faithful reproduction of the complex motions which occur in articulate speech was impossible, and that he had silently abandoned the idea of reproducing speech. A further proof of this is found in the addition of the telegraphic signal-apparatus to the later forms of the instrument, to enable the experimenters to communicate with each other. Professor Thompson's argument that the Morse signal-apparatus, if intended for verbal communication, should have been reversed, meets the facts but half way; for the complete telephonic installation required a transmitter and a receiver at each end of the wire, so that the Morse signals could be sent in either direction with the same facility as the telephonic. Moreover, as if to prevent any possible question as to its use, Reis himself expressly says that the Morse apparatus is for the purpose of enabling the operators to com-

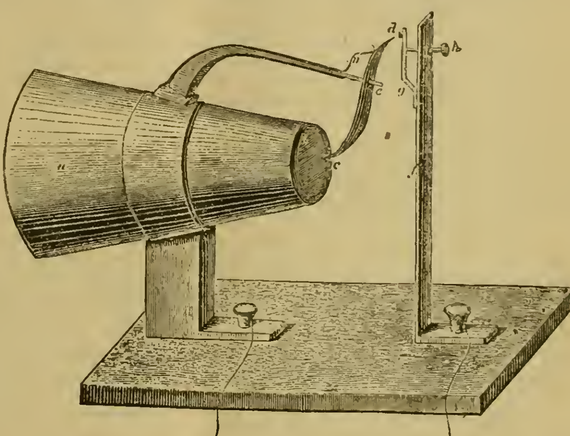


Fig. 5.

municate with each other; and, in the prospectus issued with the instruments, he describes a special alphabet, which he had devised to enable words to be spelled out. If these could be transmitted telephonically, why take this unnecessary trouble? This very provision is a most emphatic testimony that Reis, at this time, had become convinced that the apparatus as a transmitter of speech was a failure, and that, his original idea having proved impracticable, he had contented himself with sending musical tones.

In respect to this point, the letter of Reis, written by himself in English to Mr. Ladd, and given at p. 81, is most significant. He says, "Tunes and sounds of any kind are only brought to our conception by the condensations and rarefactions of air or any other medium in which we may find ourselves." And again, on p. 82, "these were the principles wich (*sic*) guided me in my invention. They were sufficient to induce me to try the reproduction of tunes at any distance." And again, on the same page, "The apparatus consists of two separated parts; one for the singing-station A, and the other for the hearing-station B." Also in the same letter, p. 84, "If a person sing at the station A, in the tube (x) the vibrations will pass into the box and move the membrane above." Respecting the word 'tunes,' used by Reis, the author remarks, in a foot-note to p. 81, "This word, as the context and ending of the paragraph shows, should have been written *tones*. The letter, written in English by Reis himself, is wonderfully free from inaccuracies of composition; the slip here noted being a most pardonable one since the plural of the German *ton* is *tönen*, the very pronunciation of which would account for the confusion in the mind of one unaccustomed to write in English." The resemblance of *tönen* to *tunes* is not so remarkably close that it would be likely to mislead one whose knowledge of English is such as Reis shows himself in this letter to possess. The author does not attempt the explanation of the words 'singing' and 'sing' in the same letter. It is surprising that he should have allowed these words to pass unnoticed, for it was vital to his argument to prove that Reis mistook them for 'speaking' and 'speak.' The resemblance is about as close as in the other case, but in neither is the explanation likely to be admitted by the unprejudiced reader.

In taking himself back to the time of Reis's telephone, the author has failed to identify himself with the conditions of that time, and to leave behind him the subsequent acquisitions of science. He makes statements and claims which could only find their justification in a world very differently furnished with facts from this one. As an illustration of the mental disposition resulting from this, the following sentence from the author's preface may serve: "The testimony now adduced as to the aim of Philipp Reis's invention, and the measure of success which he himself attained, is such, in the author's opinion, and in the opinion, he trusts, of all right-thinking persons, to place beyond cavil the rightfulness of the claim which Reis himself put forward of being the inventor of the Telephone." But did any one ever dispute this claim during his life? and has the author forgotten that no possible basis for a rival claim existed until more than two years after Reis's death? — unless we except the suggestions of Bourseul, in 1854, which, while they certainly did anticipate the general idea of Reis's invention, were never carried to the stage of experiment, and were never set up in opposition to him, unless it has been done recently. The author can hardly have been ignorant of these suggestions; but, if not, he has carefully refrained from mentioning them. Reis never claimed that no new principle could ever be discovered which would enable the ends he sought to be attained in a different way, and more perfectly. His first article upon the subject ends with these words: "There may probably remain much more yet to be done for the utilization of the telephone in practice. For physics, however, it has already sufficient interest in that it has opened out a new field of labor." And Von Legat closes his report with this remark: "There remains no doubt, that, before expecting a practical utilization with serviceable results, that which has been spoken of will require still considerable improvement, and, in particular, mechanical science must complete the apparatus to be used."

The chief aim of the book is clearly this, — to endeavor, in direct opposition to the facts, to establish the untenable proposition that the Reis transmitter was designedly contrived by him to vary the contact-resistance by pressure, giving it a microphonic action, failure to accomplish which is fatal to its success in conveying spoken words. Professor Thompson has not always been of this opinion, and in another place he has given a correct account of the relation of Reis's invention to that of Bell. In his 'Elementary lessons in electricity and magnetism,' published in 1881, we find, on pp. 405 and 406, these words, — "The first attempt to transmit sounds electrically was made in 1852 [misprint for 1862] by Reis, who succeeded in conveying musical tones by an imperfect telephone. The transmitting part of Reis's telephone consisted of a battery and a contact-breaker, the latter being formed of a stretched membrane, capable of taking up sonorous vibrations, and having attached to it a thin strip of platinum, which, as it vibrated, beat to and fro against the tip of a platinum wire, so making and breaking contact. . . . Reis also transmitted speech with this instrument, but very imperfectly, for the tones of speech cannot be transmitted by abrupt interruptions of the current. . . . In 1876 Graham Bell invented the articulating telephone. In this instrument the speaker talks to an elastic disk of thin sheet-iron, which vibrates, and transmits its every movement electrically to a similar disk in a similar telephone at a distant station, causing it to vibrate in an identical manner, and therefore to emit identical sounds." Here we have Reis spoken of as inventing '*an* imperfect telephone,' while Bell invented '*the* articulating telephone.' Reis's instrument was a 'contact-breaker,' and conveyed 'musical tones.' Reis's instrument transmitted speech 'very imperfectly,' and there is not the slightest suggestion of microphonic action in the transmitter. Yet two years later we have statements diametrically opposed to these.

The least that can be said of such varying and contradictory evidence is, that it totally destroys the credibility of the witness, and nullifies his claim to be accepted as a scientific authority, unless good reason is shown for the different opinion. The documents quoted in the book give no substantial reason for this change of ground, as they add very little of any importance to what was already generally known. The motive for the later opinions may be more intelligibly traced in the following items, which will be found in the *Telegraphic journal and electrical review*, vol. xii. p. 72, Jan., 1883, and p. 317, April 14, 1883, in the list of English patents: — "2578. Telephonic instruments. Sylvanus P. Thompson. Dated May 31. 6d. This invention relates to telephonic instruments, and chiefly to improvements in receivers of a well-known form or type, invented by Phillip Reis." "3803. Improvements in telephonic apparatus. Sylvanus P. Thompson. Dated August 9. 6d. Relates to telephonic transmitters based upon the principle discovered by Philipp Reis in 1861, namely that of employing current-regulators actuated, either directly or indirectly, by the sound-waves produced by the voice. By the term 'current-regulator,' the inventor means a device similar to that employed by Reis, wherein a loose contact between two parts of a circuit (in which are included a battery and a telephonic receiver) offers greater or less resistance to the flow of the electric current, the degree of intimacy of contact between the conducting-pieces being altered by the vibrations of the voice."

For a contrast of colors, we may put side by side with these sentences the following, from the preface to the book now under consideration: "To set forth the history of this long-neglected inventor and of his instrument, and to establish upon its own merits, without special pleading, and without partiality, the nature of that much-misunderstood and much-abused invention, has been the aim of the writer. . . . He has nothing to gain by making Reis's invention appear either better or worse than it really was."

Further comment upon the value of such testimony as is contained in this book is superfluous. What Reis accomplished, and what he failed to do, are now familiar matters of history. His well-earned fame can only suffer from such misstatement of facts, and the unjust exaggeration of his actual achievements.

OBLIGATIONS OF MATHEMATICS TO PHILOSOPHY, AND TO QUESTIONS OF COMMON LIFE.[1] — I.

Since our last meeting, we have been deprived of three of our most distinguished members. The loss by the death of Professor Henry John Stephen Smith is a very grievous one to those who knew and admired and loved him, to his university, and to mathematical science, which he cultivated with such ardor and success. I need hardly recall that the branch of mathematics to which he had specially devoted himself was that most interesting and difficult one, the theory of numbers. The immense range of this subject, connected with and ramifying into so many others, is nowhere so well seen as in the series of reports on the progress thereof, brought up, unfortunately, only to the year 1865, contributed by him to the reports of the association; but it will still better appear, when to these are united (as will be done in the collected works in course of publication by the Clarendon Press) his other mathematical writings, many of them containing his own further developments of theories referred to in the reports. There have been recently or are being published many such collected editions, — Abel, Cauchy, Clifford, Gauss, Green, Jacobi, Lagrange, Maxwell, Riemann, Steiner. Among these, the works of Henry Smith will occupy a worthy position.

More recently, Gen. Sir Edward Sabine, K.C.B., for twenty-one years general secretary of the association, and a trustee, president of the meeting at Belfast in the year 1852, and for many years treasurer, and afterwards president of the Royal society, has been taken from us at an age exceeding the ordinary age of man. Born October, 1788, he entered the Royal artillery in 1803, and commanded batteries at the siege of Fort Erie in 1814; made magnetic and other observations in Ross and Parry's north-polar exploration in 1818–19, and in a series of other voyages. He contributed to the association reports on magnetic forces in 1836, 1837, and 1838, and about forty papers to the *Philosophical transactions;* originated the system of magnetic observatories, and otherwise signally promoted the science of terrestrial magnetism.

There is yet a very great loss, — another late presi-

[1] Inaugural address by Arthur Cayley, M.A., D.C.L., LL.D., F.R.S., Sadlerian professor of pure mathematics in the University of Cambridge, president of the British association for the advancement of science, for the Southport meeting. From advance proofs kindly furnished by the editors of *Nature.*

dent and trustee of the association; one who has done for it so much, and has so often attended the meetings; whose presence among us at this meeting we might have hoped for, — the president of the Royal society, William Spottiswoode. It is unnecessary to say any thing of his various merits. The place of his burial, the crowd of sorrowing friends who were present in the Abbey, bear witness to the esteem in which he was held.

I take the opportunity of mentioning the completion of a work promoted by the association, — the determination, by Mr. James Glaisher, of the least factors of the missing three out of the first nine million numbers. The volume containing the sixth million is now published.

I wish to speak to you to-night upon mathematics. I am quite aware of the difficulty arising from the abstract nature of my subject; and if, as I fear, many or some of you, recalling the presidential addresses at former meetings, — for instance, the *résumé* and survey which we had at York of the progress, during the half-century of the lifetime of the association, of a whole circle of sciences (biology, paleontology, geology, astronomy, chemistry) so much more familiar to you, and in which there was so much to tell of the fairy-tales of science; or, at Southampton, the discourse of my friend, who has in such kind terms introduced me to you, on the wondrous practical applications of science to electric lighting, telegraphy, the St. Gothard Tunnel and the Suez Canal, gun-cotton, and a host of other purposes, and with the grand concluding speculation on the conservation of solar energy: — if, I say, recalling these or any earlier addresses, you should wish that you were now about to have, from a different president, a discourse on a different subject, I can very well sympathize with you in the feeling.

But, be this as it may, I think it is more respectful to you that I should speak to you upon, and do my best to interest you in, the subject which has occupied me, and in which I am myself most interested. And, in another point of view, I think it is right that the address of a president should be on his own subject, and that different subjects should be thus brought in turn before the meetings. So much the worse, it may be, for a particular meeting; but the meeting is the individual, which, on evolution principles, must be sacrificed for the development of the race.

Mathematics connect themselves, on the one side, with common life and the physical sciences; on the other side, with philosophy in regard to our notions of space and time, and in the questions which have arisen as to the universality and necessity of the truths of mathematics, and the foundation of our knowledge of them. I would remark here, that the connection (if it exists) of arithmetic and algebra with the notion of time is far less obvious than that of geometry with the notion of space.

As to the former side: I am not making before you a defence of mathematics; but, if I were, I should desire to do it in such manner as in the 'Republic' Socrates was required to defend justice, — quite irrespectively of the worldly advantages which may accompany a life of virtue and justice, — and to show, that, independently of all these, justice was a thing desirable in itself and for its own sake, *not* by speaking to you of the utility of mathematics in any of the questions of common life or of physical science. Still less would I speak of this utility before, I trust, a friendly audience, interested or willing to appreciate an interest in mathematics in itself and for its own sake. I would, on the contrary, rather consider the obligations of mathematics to these different subjects as the sources of mathematical theories, now as remote from them, and in as different a region of thought, — for instance, geometry from the measurement of land, or the theory of numbers from arithmetic, — as a river at its mouth is from its mountain source.

On the other side: the general opinion has been, and is, that it is indeed by experience that we arrive at the truths of mathematics, but that experience is not their proper foundation. The mind itself contributes something. This is involved in the Platonic theory of reminiscence. Looking at two things — trees or stones or any thing else — which seem to us more or less equal, we arrive at the idea of equality; but we must have had this idea of equality before the time when, first seeingt he two things, we were led to regard them as coming up more or less perfectly to this idea of equality; and the like as regards our idea of the beautiful, and in other cases.

The same view is expressed in the answer of Leibnitz, the '*nisi intellectus ipse*,' to the scholastic dictum, '*Nihil in intellectu quod non prius in sensu*' ('There is nothing in the intellect which was not first in sensation' — 'except [said Leibnitz] the intellect itself'). And so again, in the 'Critick of pure reason,' Kant's view is, that while there is no doubt but that all our cognition begins with experience, we are nevertheless in possession of cognitions *a priori*, independent, not of this or that experience, but absolutely so of all experience, and in particular that the axioms of mathematics furnish an example of such cognitions *a priori*. Kant holds, further, that space is no empirical conception which has been derived from external experiences, but that, in order that sensations may be referred to something external, the representation of space must already lie at the foundation, and that the external experience is itself first only possible by this representation of space. And, in like manner, time is no empirical conception which can be deduced from an experience, but it is a necessary representation lying at the foundation of all intuitions.

And so in regard to mathematics, Sir W. R. Hamilton, in an introductory lecture on astronomy (1836), observes, "These purely mathematical sciences of algebra and geometry are sciences of the pure reason, deriving no weight and no assistance from experiment, and isolated, or at least isolable, from all outward and accidental phenomena. The idea of order, with its subordinate ideas of number and figure, we must not, indeed, call innate ideas, if that phrase be defined to imply that all men must possess them with equal clearness and fulness: they are, however, ideas which seem to be so far born with us that the possession of them in any conceivable degree is only the development of our original powers, the unfolding of our proper humanity."

The general question of the ideas of space and time, the axioms and definitions of geometry, the axioms relating to number, and the nature of mathematical reasoning, are fully and ably discussed in Whewell's "Philosophy of the inductive sciences" (1840), which may be regarded as containing an exposition of the whole theory.

But it is maintained by John Stuart Mill that the truths of mathematics, in particular those of geometry, rest on experience; and, as regards geometry, the same view is on very different grounds maintained by the mathematician Riemann.

It is not so easy as at first sight it appears, to make out how far the views taken by Mill in his 'System of logic ratiocinative and inductive' (ninth edition, 1879) are absolutely contradictory to those which have been spoken of. They profess to be so. There are most definite assertions (supported by argument): for instance, p. 263, "It remains to inquire what is the ground of our belief in axioms, what is the evidence on which they rest. I answer, they are experimental truths, generalizations from experience. The proposition 'Two straight lines cannot enclose a space,' or, in other words, two straight lines which have once met cannot meet again, is an induction from the evidence of our senses." But I cannot help considering a previous argument (p. 259) as very materially modifying this absolute contradiction. After inquiring, "Why are mathematics by almost all philosophers . . . considered to be independent of the evidence of experience and observation, and characterized as systems of necessary truth?" Mill proceeds (I quote the whole passage) as follows: "The answer I conceive to be, that this character of necessity ascribed to the truths of mathematics, and even (with some reservations to be hereafter made) the peculiar certainty ascribed to them, is a delusion, in order to sustain which it is necessary to suppose that those truths relate to and express the properties of purely imaginary objects. It is acknowledged that the conclusions of geometry are derived, partly at least, from the so-called definitions, and that these definitions are assumed to be correct representations, as far as they go, of the objects with which geometry is conversant. Now, we have pointed out, that, from a definition as such, no proposition, unless it be one concerning the meaning of a word, can ever follow, and that what apparently follows from a definition follows in reality from an implied assumption that there exists a real thing conformable thereto. This assumption, in the case of the definitions of geometry, is not strictly true. There exist no real things exactly conformable to the definitions. There exist no real points without magnitude, no lines without breadth, nor perfectly straight, no circles with all their radii exactly equal, nor squares with all their angles perfectly right. It will be said that the assumption does not extend to the actual, but only to the possible, existence of such things. I answer, that, according to every test we have of possibility, they are not even possible. Their existence, so far as we can form any judgment, would seem to be inconsistent with the physical constitution of our planet at least, if not of the universal [*sic*]. To get rid of this difficulty, and at the same time to save the credit of the supposed system of necessary truths, it is customary to say that the points, lines, circles, and squares which are the subjects of geometry exist in our conceptions merely, and are parts of our minds; which minds, by working on their own materials, construct an *a priori* science, the evidence of which is purely mental, and has nothing to do with outward experience. By howsoever high authority this doctrine has been sanctioned, it appears to me psychologically incorrect. The points, lines, and squares which any one has in his mind are (as I apprehend) simply copies of the points, lines, and squares, which he has known in his experience. Our idea of a point I apprehend to be simply our idea of the *minimum visibile*, the small portion of surface which we can see. We can reason about a line as if it had no breadth, because we have a power which we can exercise over the operations of our minds, — the power, when a perception is present to our senses, or a conception to our intellects, of *attending* to a part only of that perception or conception, instead of the whole. But we cannot *conceive* a line without breadth; we can form no mental picture of such a line: all the lines which we have in our mind are lines possessing breadth. If any one doubt this, we may refer him to his own experience. I much question if any one who fancies that he can conceive of a mathematical line thinks so from the evidence of his own consciousness. I suspect it is rather because he supposes, that, unless such a perception be possible, mathematics could not exist as a science, — a supposition which there will be no difficulty in showing to be groundless."

I think it may be at once conceded that the truths of geometry are truths precisely because they relate to and express the properties of what Mill calls 'purely imaginary objects.' That these objects do not exist in Mill's sense, that they do not exist in nature, may also be granted. That they are 'not even possible,' if this means not possible in an existing nature, may also be granted. That we cannot 'conceive' them depends on the meaning which we attach to the word 'conceive.' I would myself say that the purely imaginary objects are the only realities, the ὄντως ὄντα, in regard to which the corresponding physical objects are as the shadows in the cave; and it is only by means of them that we are able to deny the existence of a corresponding physical object. If there is no conception of straightness, then it is meaningless to deny the existence of a perfectly straight line.

But, at any rate, the objects of geometrical truth are the so-called imaginary objects of Mill; and the truths of geometry are only true, and *a fortiori* are only necessarily true, in regard to these so-called imaginary objects. And these objects, points, lines, circles, etc., in the mathematical sense of the terms, have a likeness to, and are represented more or less imperfectly, — and, from a geometer's point of view, no matter how imperfectly, — by corresponding physical points, lines, circles, etc. I shall have to return to geometry, and will then speak of Riemann; but I will first refer to another passage of the 'Logic.'

Speaking of the truths of arithmetic, Mill says (p. 297) that even here there is one hypothetical element: "In all propositions concerning numbers, a condition is implied without which none of them would be true; and that condition is an assumption which may be false. The condition is, that 1=1; that all the numbers are numbers of the same or of equal units." Here, at least, the assumption may be absolutely true: one shilling=one shilling in purchasing-power, although they may not be absolutely of the same weight and fineness. But it is hardly necessary: one coin+one coin=two coins, even if the one be a shilling and the other a half-crown. In fact, whatever difficulty be raisable as to geometry, it seems to me that no similar difficulty applies to arithmetic. Mathematician or not, we have each of us, in its most abstract form, the idea of a number. We can each of us appreciate the truth of a proposition in regard to numbers; and we cannot but see that a truth in regard to numbers is something different in kind from an experimental truth generalized from experience. Compare, for instance, the proposition that the sun, having already risen so many times, will rise to-morrow, and the next day, and the day after that, and so on, and the proposition that even and odd numbers succeed each other alternately *ad infinitum:* the latter, at least, seems to have the characters of universality and necessity. Or, again, suppose a proposition observed to hold good for a long series of numbers, — one thousand numbers, two thousand numbers, as the case may be: this is not only no proof, but it is absolutely no evidence, that the proposition is a true proposition, holding good for all numbers whatever. There are, in the theory of numbers, very remarkable instances of propositions observed to hold good for very long series of numbers, and which are nevertheless untrue.

I pass in review certain mathematical theories.

In arithmetic and algebra, or, say, in analysis, the numbers or magnitudes which we represent by symbols are, in the first instance, ordinary (that is, positive) numbers or magnitudes. We have also in analysis, and in analytical geometry, *negative* magnitudes. There has been, in regard to these, plenty of philosophical discussion, and I might refer to Kant's paper, 'Ueber die negativen grössen in die weltweisheit' (1763); but the notion of a negative magnitude has become quite a familiar one, and has extended itself into common phraseology. I may remark that it is used in a very refined manner in book-keeping by double entry.

But it is far otherwise with the notion which is really the fundamental one (and I cannot too strongly emphasize the assertion), underlying and pervading the whole of modern analysis and geometry, — that of imaginary magnitude in analysis, and of imaginary space (or space as a *locus in quo* of imaginary points and figures) in geometry. I use in each case the word 'imaginary' as including real. This has not been, so far as I am aware, a subject of philosophical discussion or inquiry. As regards the older metaphysical writers, this would be quite accounted for by saying that they knew nothing, and were not bound to know any thing, about it. But at present, and considering the prominent position which the notion occupies, — say, even, that the conclusion were that the notion belongs to mere technical mathematics, or has reference to nonentities in regard to which no science is possible, — still it seems to me, that, as a subject of philosophical discussion, the notion ought not to be thus ignored. It should at least be shown that there is a right to ignore it.

Although in logical order I should perhaps now speak of the notion just referred to, it will be convenient to speak first of some other quasi-geometrical notions, — those of more-than-three-dimensional space, and of non-Euclidian two- and three-dimensional space, and also of the generalized notion of distance. It is in connection with these, that Riemann considered that our notion of space is founded on experience, or, rather, that it is only by experience that we know that our space is Euclidian space.

It is well known that Euclid's twelfth axiom, even in Playfair's form of it, has been considered as needing demonstration, and that Lobatschewsky constructed a perfectly consistent theory, wherein this axiom was assumed not to hold good, or, say, a system of non-Euclidian plane geometry. There is a like system of non-Euclidian solid geometry. My own view is, that Euclid's twelfth axiom, in Playfair's form of it, does not need demonstration, but is part of our notion of space, of the physical space of our experience, — the space, that is, with which we become acquainted by experience, but which is the representation lying at the foundation of all external experience. Riemann's view, before referred to, may, I think, be said to be, that, having *in intellectu* a more general notion of space (in fact, a notion of non-Euclidian space), we learn by experience that space (the physical space of our experience) is — if not exactly, at least to the highest degree of approximation — Euclidian space.

But suppose the physical space of our experience to be thus only approximately Euclidian space: what is the consequence which follows? *Not* that the propositions of geometry are only approximately true, but that they remain absolutely true in regard to that Euclidian space which has been so long regarded as being the physical space of our experience.

It is interesting to consider two different ways in which, without any modification at all of our notion of space, we can arrive at a system of non-Euclidian (plane or two-dimensional) geometry; and the doing so will, I think, throw some light on the whole question.

First, imagine the earth a perfectly smooth sphere; understand by a plane the surface of the earth, and, by a line, the apparently straight line (in fact, an arc of great circle) drawn on the surface. What experience would in the first instance teach would be Euclidian geometry: there would be intersecting lines, which, produced a few miles or so, would seem to go on diverging, and apparently parallel lines, which would exhibit no tendency to approach each other; and the inhabitants might very well conceive that they had by experience established the axiom that two straight lines cannot enclose a space, and the axiom as to parallel lines. A more extended experience and more accurate measurements would teach them that the axioms were each of them false; and that any two lines, if produced far enough each way, would meet in two points: they would, in fact, arrive at a spherical geometry, accurately representing the properties of the two-dimensional space of their experience. But their original Euclidian geometry would not the less be a true system; only it would apply to an ideal space, not the space of their experience.

Secondly, consider an ordinary, indefinitely extended plane; and let us modify only the notion of distance. We measure distance, say, by a yard measure or a foot rule, any thing which is short enough to make the fractions of it of no consequence (in mathematical language, by an infinitesimal element of length). Imagine, then, the length of this rule constantly changing (as it might do by an alteration of temperature), but under the condition that its actual length shall depend only on its situation on the plane, and on its direction; viz., if for a given situation and direction it has a certain length, then whenever it comes back to the same situation and direction it must have the same length. The distance along a given straight or curved line between any two points could then be measured in the ordinary manner with this rule, and would have a perfectly determinate value; it could be measured over and over again, and would always be the same: but of course it would be the distance, not in the ordinary acceptation of the term, but in quite a different acceptation. Or in a somewhat different way: if the rate of progress from a given point in a given direction be conceived as depending only on the configuration of the ground, and the distance along a given path between any two points thereof be measured by the time required for traversing it, then in this way, also, the distance would have a perfectly determinate value; but it would be a distance, not in the ordinary acceptation of the term, but in quite a different acceptation; and, corresponding to the new notion of distance, we should have a new non-Euclidian system of plane geometry. All theorems involving the notion of distance would be altered.

We may proceed farther. Suppose that as the rule moves away from a fixed central point of the plane it becomes shorter and shorter: if this shortening take place with sufficient rapidity, it may very well be that a distance which in the ordinary sense of the word is finite will in the new sense be infinite. No number of repetitions of the length of the ever-shortening rule will be sufficient to cover it. There will be surrounding the central point a certain finite area, such that (in the new acceptation of the term 'distance') each point of the boundary thereof will be at an infinite distance from the central point. The points outside this area you cannot by any means arrive at with your rule: they will form a *terra incognita*, or, rather, an unknowable land (in mathematical language, an imaginary or impossible space); and the plane space of the theory will be that within the finite area, that is, it will be finite instead of infinite.

We thus, with a proper law of shortening, arrive at a system of non-Euclidian geometry which is essentially that of Lobatschewsky; but, in so obtaining it, we put out of sight its relation to spherical geometry. The three geometries (spherical, Euclidian, and Lobatschewsky's) should be regarded as members of a system: viz., they are the geometries of a plane (two-dimensional) space of constant positive curvature, zero curvature, and constant negative curvature, respectively; or, again, they are the plane geometries corresponding to three different notions of distance. In this point of view, they are Klein's elliptic, parabolic, and hyperbolic geometries respectively.

Next as regards solid geometry: we can, by a modification of the notion of distance (such as has just been explained in regard to Lobatschewsky's system), pass from our present system to a non-Euclidian system. For the other mode of passing to a non-Euclidian system, it would be necessary to regard our space as a flat three-dimensional space existing in a space of four dimensions (i.e., as the analogue of a plane existing in ordinary space), and to substitute for such flat three-dimensional space a curved three-dimensional space, say, of constant positive or negative curvature. In regarding the physical space of our experience as possibly non-Euclidian, Riemann's idea seems to be that of modifying the notion of distance, not that of treating it as a locus in four-dimensional space.

I have just come to speak of four-dimensional space. What meaning do we attach to it? or can we attach to it any meaning? It may be at once admitted that we cannot conceive of a fourth dimension of space; that space as we conceive of it, and the physical space of our experience, are alike three-dimensional. But we can, I think, conceive of space as being two- or even one-dimensional; we can imagine rational beings living in a one-dimensional space (a line) or in a two-dimensional space (a surface), and conceiving of space accordingly, and to whom, therefore, a two-dimensional space or (as the case may be) a three-dimensional space would be as inconceivable as a four-dimensional space is to us. And very curious speculative questions arise. Suppose the one-dimensional space a right line, and that it afterwards becomes a curved line: would there be any indication of the change? or, if originally a curved line, would there be any thing to suggest to them that it was not a right line? Probably not; for a one-dimensional geometry hardly exists. But let the space be two-dimensional, and imagine it originally a plane, and afterwards bent (converted, that is, into some form of developable surface), or converted into a curved surface; or imagine it originally a developable or curved surface. In the former case there should be an indication of the change, for the geometry originally applicable to the space of their experience (our own Euclidian geometry) would cease to be applicable; but the change could not be apprehended by them as a bending or deformation of the plane, for this would imply the notion of a three-dimensional space in which this bending or deformation could take place. In the latter case their geometry would be that appropriate to the developable or curved surface which is their space; viz., this would be their Euclidian geometry. Would they ever have arrived at our own more simple system? But take the case where the two-dimensional space is a plane, and imagine the beings of such a space familiar with our own Euclidian plane geometry: if, a third dimension being still inconceivable by them, they were by their geometry or otherwise led to the notion of it, there would be nothing to prevent them from forming a science such as our own science of three-dimensional geometry.

Evidently, all the foregoing questions present themselves in regard to ourselves, and to three-dimensional space as we conceive of it, and as the physical space of our experience. And I need hardly say that the first step is the difficulty, and that, granting a fourth dimension, we may assume as many more dimensions as we please. But, whatever answer be given to them, we have, as a branch of mathematics, potentially if not actually, an analytical geometry of n-dimensional space. I shall have to speak again upon this.

Coming now to the fundamental notion already referred to, — that of imaginary magnitude in analysis, and imaginary space in geometry; I connect this with two great discoveries in mathematics, made in the first half of the seventeenth century, — Harriot's representation of an equation in the form $f(x) = 0$, and the consequent notion of the roots of an equation as derived from the linear factors of $f(x)$ (Harriot, 1560–1621: his 'Algebra,' published after his death, has the date 1631); and Descartes' method of co-ordinates, as given in the 'Géometrie' forming a short supplement to his 'Traité de la méthode,' etc. (Leyden, 1637).

I show how by these we are led analytically to the notion of imaginary points in geometry. For instance: we arrive at the theorem that a straight line and circle in the same plane intersect *always* in two points, real or imaginary. The conclusion as to the two points of intersection cannot be contradicted by experience. Take a sheet of paper and draw on it the straight line and circle, and try. But you might say, or at least be strongly tempted to say, that it is meaningless. The question, of course, arises, What is the meaning of an imaginary point? and, further, In what manner can the notion be arrived at geometrically?

There is a well-known construction in perspective for drawing lines through the intersection of two lines which are so nearly parallel as not to meet within the limits of the sheet of paper. You have two given lines which do not meet, and you draw a third line, which, when the lines are all of them produced, is found to pass through the intersection of the given lines. If, instead of lines, we have two circular arcs not meeting each other, then we can, by means of these arcs, construct a line; and if, on completing the circles, it is found that the circles intersect each other in two real points, then it will be found that the line passes through these two points: if the circles appear not to intersect, then the line will appear not to intersect either of the circles. But the geometrical construction being in each case the same, we say that in the second case, also, the line passes through the two intersections of the circles.

Of course, it may be said in reply, that the conclusion is a very natural one, provided we assume the existence of imaginary points; and that, this assumption not being made, then, if the circles do not intersect, it is meaningless to assert that the line passes through their points of intersection. The difficulty is not got over by the analytical method before referred to, for this introduces difficulties of its own. Is there, in a plane, a point the co-ordinates of which have given imaginary values? As a matter of fact, we do consider, in plane geometry, imaginary points introduced into the theory analytically or geometrically, as above.

The like considerations apply to solid geometry; and we thus arrive at the notion of imaginary space as a *locus in quo* of imaginary points and figures.

I have used the word 'imaginary' rather than 'complex,' and I repeat that the word has been used as including real. But, this once understood, the word becomes in many cases superfluous, and the use of it would even be misleading. Thus: 'a problem has so many solutions.' This means so many imaginary (including real) solutions. But if it were said that the problem had 'so many imaginary solutions,' the word 'imaginary' would here be understood to be used in opposition to real. I give this explanation the better to point out how wide the application of the notion of the imaginary is; viz. (unless expressly or by implication excluded), it is a notion implied and presupposed in all the conclusions of modern analysis and geometry. It is, as I have said, the fundamental notion underlying and pervading the whole of these branches of mathematical science.

I consider the question of the geometrical representation of an imaginary variable. We represent the imaginary variable $x + iy$ by means of a point in a plane, the co-ordinates of which are (x, y). This idea, due to Gauss, dates from about the year 1831. We thus picture to ourselves the succession of values of the imaginary variable $x + iy$ by means of the motion of the representative point: for instance, the succession of values corresponding to the motion of the point along a closed curve to its original position. The value $X + iY$ of the function can, of course, be represented by means of a point (taken for greater convenience in a different plane), the co-ordinates of which are X, Y.

We may consider, in general, two points, moving each in its own plane; so that the position of one of them determines the position of the other, and consequently the motion of the one determines the motion of the other. For instance: the two points may be the tracing-point and the pencil of a pentagraph. You may with the first point draw any figure you please: there will be a corresponding figure drawn by the second point, — for a good pentagraph, a copy on a scale different, it may be; for a badly adjusted pentagraph, a distorted copy; but the one figure will always be a sort of copy of the first, so that to each point of the one figure there will correspond a point in the other figure.

In the case above referred to, where one point represents the value $x+iy$ of the imaginary variable, and the other the value $X+iY$ of some function, $\phi(x+iy)$, of that variable, there is a remarkable relation between the two figures: this is the relation of orthomorphic projection, the same which presents itself between a portion of the earth's surface and the representation thereof by a map on the stereographic projection or on Mercator's projection; viz., any indefinitely small area of the one figure is represented in the other figure by an indefinitely small area of the same shape. There will possibly be for different parts of the figure great variations of scale, but the shape will be unaltered. If for the one area the boundary is a circle, then for the other area the boundary will be a circle: if for one it is an equilateral triangle, then for the other it will be an equilateral triangle.

I have been speaking of an imaginary variable $(x+iy)$, and of a function, $\phi(x+iy)=X+iY$, of that variable; but the theory may equally well be stated in regard to a plane curve: in fact, the $x+iy$ and the $X+iY$ are two imaginary variables connected by an equation. Say their values are u and v, connected by an equation, $F(u, v) = 0$: then, regarding u, v, as the co-ordinates of a point *in plano*, this will be a point on the curve represented by the equation. The curve, in the widest sense of the expression, is the whole series of points, real or imaginary, the co-ordinates of which satisfy the equation; and these are exhibited by the foregoing corresponding figures in two planes. But, in the ordinary sense, the curve is the series of real points, with co-ordinates u, v, which satisfy the equation.

In geometry it is the curve, whether defined by means of its equation or in any other manner, which is the subject for contemplation and study. But we also use the curve as a representation of its equation; that is, of the relation existing between two magnitudes, x, y, which are taken as the co-ordinates of a point on the curve. Such employment of a curve for all sorts of purposes — the fluctuations of the barometer, the Cambridge boat-races, or the funds — is familiar to most of you. It is in like manner convenient in analysis, for exhibiting the relations between any three magnitudes, x, y, z, to regard them as the co-ordinates of a point in space; and, on the like ground, we should at least wish to regard any four or more magnitudes as the co-ordinates of a point in space of a corresponding number of dimensions. Starting with the hypothesis of such a space, and of points therein, each determined by means of its co-ordinates, it is found possible to establish a system of n-dimensional geometry analogous in every respect to our two- and three-dimensional geometries, and to a very considerable extent serving to exhibit the relations of the variables.

It is to be borne in mind that the space, whatever its dimensionality may be, must always be regarded as an imaginary or complex space, such as the two- or three-dimensional space of ordinary geometry. The advantages of the representation would otherwise altogether fail to be obtained.

I omit some farther developments in regard to geometry, and all that I have written as to the connection of mathematics with the notion of time.

(To be continued.)

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

STATE INSTITUTIONS.

Illinois state laboratory of natural history, Normal, Ill.

Experiments with diseased caterpillars. — Prof. S. A. Forbes is making a special study of 'schlaffsucht,' or some very similar disease, among our native caterpillars. He has so far proven that the disease is characterized by an enormous development of bacteria in the alimentary canal, the same forms appearing in the blood before death; that it is contagious by way of the food ingested; that the characteristic bacteria may be easily and rapidly cultivated in sterilized beef-broth; and that caterpillars whose food has been moistened with this infected broth, speedily show the bacteria in the alimentary canal, and, later, in the blood, and soon all die of the disease. Other caterpillars of the same lot, receiving the same treatment, except that the food is moistened with distilled water instead of the infected broth, remain unaffected. These bacteria are likewise cultivable in vegetable infusions, but multiply there less freely.

Every step of the investigation is fortified by stained and mounted preparations, which are being submitted to cryptogamists. It has already been determined that the bacterium infesting a brood of Datana ministra in his breeding-cages is identical with the Micrococcus bombycis of the silk-worm; the form, measurements, modes of aggregation, and behavior to reagents, of the two, being the same. Datana Angusii, feeding upon walnut, was also occasionally infested by this M. bombycis, but much more commonly by a spherical species, probably undescribed.

In the cabbage-worm (Pieris rapae) occurs still another species of Micrococcus, very minute ($5\,\mu$ in diameter), globular, and usually either single or in pairs. This is far the most virulent of the insect affections, which is being studied by Forbes, — the most like a plague. In its earlier stages it can usually be recognized by the light tint of the larvae, an ashy green, so different from the ordinary color that one may pick out the diseased worms at a glance. These soon become torpid, and commonly die in a few hours. After death, decomposition is peculiarly sudden and rapid. A pale individual, picked out in the evening while still active, at eight o'clock the following morning was dead, blackened, and almost deliquescent, the whole body being reduced to a semi-fluid condition. This Micrococcus multiplies rapidly in beef-broth, rendering the fluid turbid.

The cultures of these Micrococci are made by the most rigorous use of the modern methods of 'pure culture.'

Only M. bombycis has thus far been successfully used by Forbes for the infection of healthy larvae; but experiments with the other species are now in progress. Measures are also being taken to learn the length of life of these bacteria when kept in hermetically-sealed tubes, with the expectation that this will furnish a means of preserving and transporting them for practical use, if this should prove to be worth while.

Forbes is also experimenting with the various ferment-germs appearing spontaneously in organic infusions, and has noted the occasional appearance of large numbers of Saccharomyces in the intestines of unhealthy larvae, and of those whose food has been treated with fermenting vegetable infusions.

NOTES AND NEWS.

We deeply regret to announce the death of Dr. Hermann Müller, on Aug. 25. Next to Darwin, Müller has done the most to advance our knowledge of the mutual relations between plants and animals in one of its many phases. Some notice of his life and work will be given in a future number.

—The boundary-line between Guatemala and Mexico, which, as we announced last week, Mr. Miles Rock has been commissioned to locate, is about two hundred miles in length; and one or two years will be required to finish the work. Astronomical stations will be established along the line, and topographical and profile maps will be made to extend as far as time and means will permit. If possible, the longitude of Guatemala City will be determined telegraphically by connecting with some point on the coast occupied by the U. S. hydrographic party under Lieut.-Commander Davis.

Mr. Rock has also been commissioned by the Smithsonian institution to collect notes on anthropology in the country over which his survey extends, and to photograph whatever archeological ruins he may meet with during the progress of the survey. He sailed from New York on Oct. 1, in the steamer Acapulco.

—The annual report of the librarian of the public library of Cincinnati for the year ending June, 1883, has just been issued. The total number of volumes and pamphlets in the library is 149,750. "The average number of books loaned daily for home use has been 680. The average number delivered for use in the reading-room has been 379 per day." In tables showing the number of books issued for home use and for consultation are given percentages for various classes. Fiction heads the list with 81.4% in books for home use, and 28.3% in the reading-room. Science and arts are represented by only 2.9% for home use, but rise to 24.8% for books consulted at the library. The number of volumes of fiction circulated during the year was 167,678, and of science and arts only 5,928. In the consulting-room, however, 39,539 volumes of fiction were issued, and 33,916 volumes in science and arts. Though these figures show a marked preponderance in the circulation of fiction over science and arts, as indeed they do over every other class, the preponderance is perhaps more apparent than real. As the librarian says in his report, these percentages are often misleading. "They lead the public to believe that a much larger than a true proportion of the work of a library is in the distribution of books calculated to entertain rather than to instruct. Probably not more than one-sixth of the time devoted to a volume of history or of science is devoted to a novel by the average reader; and yet in these figures volumes of history and science count equally with volumes of fiction and juvenile literature."

In a table 'showing the number and the classes of books used during each month of the year,' we find some interesting figures. More books were used during the months of January and March than during any other two months of the year. In philology there was nearly a regular increase from month to month from July to January, and a decrease to June. In history, from 1,387 volumes in December, there was an increase to 1,818 in January, decrease to 1,385 in February, and increase again to 1,586 and 1,581 in March and April respectively. In geography and travels, March takes the lead with 1,006. In science and arts the increase is regular from July (2,558) to January (4,656), when the decrease commences; and in June we have 2,838. In the totals we find that nearly 40% of the books were used during the months of December, January, February, and March; while only about 28% were used during June, July, August, and September.

—The latest news from the French deep-sea explorations on the Talisman is comprised in a letter from M. Alph. Milne-Edwards, at Teneriffe. Every thing had worked in a satisfactory manner. Many soundings had been made off the coast of Morocco, and interesting profiles of the bottom thereby developed. Bottom and water specimens were simultaneously obtained, and the work was even carried on at night by the aid of electric lights. Considerable zoölogical collections had been made, and the professor was especially devoting himself to the study of their distribution in depth. The character of the fauna already enabled a tolerable estimation of the depth to be made from an examination of the animals contained in any particular haul of the dredge. By the use of extremely large nets, better luck had been secured in the capture of deep-sea fishes than had previously attended their efforts, and a large number of specimens had been obtained. On leaving the Canaries, the expedition would proceed to the Cape Verde Islands, and thence along the so little known African coast.

—Mr. H. J. Johnston-Levis publishes the accompanying map of Ischia (scale 1 : 80,000) in *Nature*, with some further account of the recent earthquake. In company with Prof. P. Franco of Naples, he travelled over the whole island without detecting any sign of volcanic action. If isoseismal lines are drawn over the injured districts, we find, he says, "that they assume the form of elongated ellipsoids, whose major axes run nearly east and west." In the

first isoseismal area, *a*, *a*, destruction was total; in the second, *b*, *b*, many houses are fallen, and the rest will require rebuilding; in the third, c, c, they were severely fissured; the fourth, in which houses were only very slightly fissured, not only includes the whole island, but must extend into the sea some distance. "From a careful examination of observed azimuths and angles of emergence, all point to a plate-shaped focus, whose strike extends in a line from Fontana, just west of Menella, to near the beach at Lacco. The plane of this fissure is probably roughly perpendicular to the surface, but may slightly dip towards the east, as the isoseismals are slightly nearer on the eastern side of the seismic vertical, which, as a necessity, is not represented by a point, but a line on the surface. The rupturing of this plate-like fissure was apparently greatest at a point nearly midway between its extremities." The ancient eruptive centres and craters are marked on the map in dotted circles.

—Ensign S. J. Brown, U. S. navy, has been elected professor of mathematics in the navy, and assigned to duty at the Naval observatory in Washington.

—Thouar writes from La Paz, under date of May 31 last, that in his search for Crevaux he had arrived by the way of Tacna, across the Cordilleras, on the 28th. The Bolivian government, by Sig. A. Quijarro, minister of foreign affairs, had shown great interest in the plans, and desire to assist to the extent of its power. An expeditionary corps had been equipped, and directed to march on Teyo, the Toba capital, which it is designed to occupy while part of the force descends the right bank of the Pilcomayo to Ascension. This expedition should have left Caiza in the month of June last, while, on the 3d, Thouar intended to start for Caripari, *viâ* Oruro, Potosi, Sucre, and Tarija.

—Endeavors have been made during the past session of the English parliament to obtain such amendments of the Factory acts as would protect not only the overworked and overheated workers in the bakehouses, but those desperate men who face certain death by poisoning in the manufacture of white lead. No act of parliament, however, will be of any real use until some improved process makes safety as cheap as danger. Lately, with this object in view, Prof. C. Gardner has perfected an invention through which, by electrical energy and the cheap production of carbonic acid, applied through a special apparatus, in combination with the necessary acid vapor at the proper temperature, the formation of white lead of the purest color and best quality is rapidly and cheaply carried out in closed chambers; the lead resting upon shelves, which are lifted out when converted, and emptied, without any dust being raised, into a combination of machinery closed in, from which it comes forth as white paint ground ready for the market, or, if required, as dry powder. In either case the dangerous operations of the 'white bed,' and washing and stoving, are completely done away with, and no opportunity is given for the dust to enter the air, or touch the persons of the workers.

—Mr. G. Brown Goode, U. S. commissioner to the fisheries exhibition, sailed from London for the United States on the 19th ult.

—The summer station of the U. S. fish-commission at Wood's Holl, Mass., will remain open until about the 20th of this month, at which time the commissioner will return to Washington.

—Dr. R. W. Shufeldt, U.S.A., who was engaged in making collections in Louisiana, has been released from duty on account of ill health.

—Mr. Robert Ridgway has left his duties at the national museum for the present on account of ill health, and is recruiting in New York.

—Dr. Charles Rau has in preparation a monographic work upon prehistoric fishing-implements. It will be published as one of the Smithsonian Contributions to knowledge.

—Professor Lester F. Ward has returned from the west. He reports having thoroughly explored about seventeen hundred miles of the Missouri River.

—The very prevalent idea that aniline dyes have poisonous properties has inspired the German chemist, Dr. Grandhomme, to investigate the subject as illustrated in the coal-tar color-works of Messrs. Lucius and Brüning at Höchst-on-the-Main. Nowhere else could these researches have been conducted in so satisfactory a manner, as the Höchst color-works employ six hundred and seventy-two men in the actual manufacture of the colors, exclusive of their large staff of mechanics and laboratory assistants. One regulation provides that no workman shall enter any other department than his own; so that the works offer an excellent field for accurate observation. The following results were obtained by Dr. Grandhomme from personal observation, and the tables of accident and illness kept in the works. Nitrobenzol is known to be poisonous, yet symptoms of nitrobenzol-poisoning only appeared in the cases of illness reported in that department during four years. Aniline is unquestionably poisonous; yet, out of one hundred and seventy-one cases of illness in that department, only eighteen were due to aniline: none were fatal, and the average duration of the illness was one and one-half days. Magentas made by the arsenic process, and duly purified, are recognized as poisons; but the symptoms recorded are those produced by arsenic, which, in some inferior magentas, exists in the proportion of even eight per cent. No illness caused by pure magenta was recorded at Höchst, and aniline no more exists in the finished magenta than manure exists in wheat. In the department where blue colors were made, only one case of aniline-poisoning was recorded; none in the violet and green departments. A special disease appeared in the eosine department, causing extreme perspirations from the pores of the hands, but not among the men employed in packing the finished colors. No special disease was noted in the naphthol and alizarine departments. The use of alcohol was found to reduce the power of the constitution to bear the action of aniline: so no alcoholic drinks were allowed in the Höchst works, and no men addicted to drinking admitted.

—In Namaqua-land, South Africa, no rain has fallen since Aug. 15, 1881, and plants, animals, and men are dying of drought and starvation. Wheat and seeds have been sent by the Cape Colony, and a relief committee has been formed.

—Tillo has determined the total length of navigable rivers in European Russia, which is only 72,000 kilometres for that vast territory, a deficiency due to the dryness of the climate.

RECENT BOOKS AND PAMPHLETS.

Bacharach, M. Abriss der geschichte der potentialtheorie. Göttingen, *Vandenbroeck & Ruprecht,* 1883. 3+78 p. 8°.

Birnbaum, K. Die prüfung der nahrungsmittel und gebrauchs-gegenstände im grossherzogthum Baden und die resultate einiger in der mit dem chemischen laboratorium des polytechnikums in Karlsruhe verbundenen prüfungs station ausgeführten untersuchungen. Karlsruhe, *Braun,* 1883. 8+119 p., 1 pl. 8°.

Brass, A. Biologische studien. theil 1.: Die organisation der thierischen zelle. heft i. Halle, *Strien,* 1883. 8+80 p., 4 pl. 8°.

Claus, C. Fragment einer monographie des platins und der platinmetalle, 1865-83. Leipzig, *Voss,* 1883. 5+92 p. 8°.

Handwörterbuch der chemie. Herausgegeben von Prof. Dr. Ladenburg unter mitwirkung von Dr. Berend, Dr. Biedermann, Prof. Dr. Drechsel, etc. band i. Breslau, *Trewendt,* 1883. 8+712 p., illustr. 8°.

Hopkins, Louisa Parsons. Handbook of the earth: natural methods in geography. Boston, *Lee & Shepard,* 1883. 78 p. 24°.

Kaempfer, D. Ueber die messung electrischer kräfte mittelst des electrischen flugrads. (Inaug. diss.) Berlin, *Friedländer,* 1883. 36 p. 8°.

Lowe, O. Ueber die regulären und Poinsot'schen körper und ihre inhalts bestimmung vermittelst determinanten. München, *Rieger,* 1883. 28 p., 1 pl. 8°.

Merkmal, das verlorene, des winkel-begriffes eine folge der fortschreitenden bewegung auf dem gebiete der geometrischen formenlehre nach wesentlichen ideen und neuen gesichtspunkten. Teschen, *Cotula,* 1883. 23 p. 8°.

Petzoldt, K. Petrographische studier an basaltgesteinen der Rhön. (Inaug. diss.) Halle, *Tausch,* 1883. 48 p. 8°.

Samuels, E. A. Our northern and eastern birds. New York, *Worthington,* 1883. 600 p., illustr. 8°.

Schmitz, F. Die vegetation des meeres. Bonn, *Strauss,* 1883. 21 p. 8°.

Smoke abatement committee, 1882, report of. With reports of the jurors of the exhibition at South Kensington, and of the testing engineer, to which are added the official reports on the Manchester exhibition. London, *Smith, Elder, & Co.,* 1883. 14+193 p., 76 pl. 4°.

Taugermann, J. D. Licht, harmonie und kraft. Eine naturwissenschaftlich-philosophische studie. Leipzig, *Mutze,* 1883. 70 p. 8°.

Tischner, A. The sun changes its position in space, therefore it cannot be regarded as being 'in a condition of rest.' Leipzig, *Fork,* 1883. 37 p. 12°.

SCIENCE.

FRIDAY, OCTOBER 12, 1883.

HERMANN MÜLLER.[1]

THE sad news has just reached this country of the death of Professor Müller, at Prad, on the 25th of August.

Since the death of Mr. Darwin, Dr. Müller has occupied the position of most prominence among students of the mutual relations between flowers and insects, — a study which, in the last decade, has contributed as much as any branch of biology to the substantiation of the main points of adaptive evolution. Müller was born at Mühlberg, Sept. 23, 1829, and was a younger brother of the well-known Brazilian naturalist, Fritz Müller, much of whose work has passed through his hands before its publication.

Between 1848 and 1852 he studied at the universities of Halle and Berlin, devoting himself to natural history. In the latter year he passed the Oberlehrer examinations, and served his novitiate in the Berlin realschule. In 1854 he received his first appointment as teacher in the school at Schwerin, and the following year took the natural sciences in the realschule at Lippstadt, where he remained as teacher and director until his death.

Previously to the attainment of his degree, Dr. Müller had shown considerable zeal in natural history explorations, which were continued, in 1855, in the vicinity of Krain, where he did some especially interesting work on the blind insects found in the caves at this place, the results of his studies appearing in the *Stettiner entomologische zeitschrift* for 1856–57. After settling at Lippstadt, he gave particular attention to botany and entomology, working up, in particular, the local phenogamic flora, and later the mosses of Westphalia, sets of which were distributed by him between 1864 and 1866.

About this time the classical work of Darwin on the fertilization of orchids by insects directed his attention to the pollination of flowers, — a subject, which, neglected since the time of Sprengel, was then attracting several biologists. His familiarity with Westphalian plants and insects fitted him especially for work of this nature; and his first contributions[2] showed that he was also possessed of the requisite powers of observation and interpretation.

From this time on, his leisure was given to field-work in this specialty, many of his summers being spent in the Alps. While Delpino, Hildebrand, and others were not slow to follow in the steps of Mr. Darwin, showing, both from the structure of flowers and the results of many careful experiments, how they must *a priori* be fertilized, Müller observed, in addition, how their pollination is actually effected; and our knowledge of the degree to which the reciprocal adaptations of flowers and their visitors extends may be set down as in large part the result of his labors.

In the past ten years, numerous papers from

[1] The portrait on this page is engraved from a photograph by Ophoven of Lippstadt, kindly furnished by Prof. William Trelease of the University of Wisconsin.

[2] Beobachtungen an Westfälischen orchideen (*Verhandl. naturh. ver. Preuss. Rheinl. u. Westfalens*, 1868) and Anwendung der Darwin'sche lehre auf bienen (*ibid.*, 1872).

his pen have appeared in the *Botanische zeitung*, *Bienen zeitung*, *Kosmos*, *Nature*, etc., while, as editor of the department of Justs' *Jahresbericht*, relating to pollination and dissemination, he has contributed reviews of all of the more important publications bearing on his specialty. Beside these, he published two books, — Befruchtung der blumen durch insekten, und die gegenseitigen anpassungen beider (which appeared in 1873, served as the basis of a very instructive series of articles in *Nature*, and was largely drawn upon by Lubbock in the preparation of his little work on British wild-flowers, and which, supplemented by the more recent observations of its author, has lately been translated into English); and Alpenblumen, ihre befruchtung durch insekten und ihre anpassungen an dieselben (a volume of equal size, published in 1881, and, like its predecessor, filled with instructive facts).

From the first, Dr. Müller was a pronounced evolutionist, perhaps erring in too exclusive contemplation of a limited part of the evidence of derivation; and, like many others of the German school, inclined to push evolutionary logic to its ultimate if undemonstrable conclusion of materialism.

As a teacher he was most excellent, having the faculty, not only of imparting ideas to his pupils, but of inspiring their enthusiasm. In his specialty he was a careful observer, noting and accounting for many minute structural peculiarities in both flowers and insects, which, so long as their utility remained undiscovered, were explicable only by the theory of types in nature. So far as observation is concerned, his work is above criticism. As a rule, too, his inferences are correctly drawn, though the limitation of his studies to a small part of the world has at times rendered his enthusiasm over the biological significance of some supposed new adaptation, subject to the criticism of specialists previously familiar with the structure, if not with its meaning.

As a friend, Dr. Müller was always cordial, ever ready with encouragement and assistance for younger workers in the line of his specialty. He had, however, little patience with inaccuracy in observation, and, both publicly and in private, criticised errors with vigor; but, though his criticisms were sometimes severe, they were seldom unkind, and never unjust. By his death, biological science loses not only one of its most enthusiastic and able devotees, but also one, who, by the independent and thorough nature of his work, may be styled not inappropriately an epoch-maker.

THE USE OF THE SPECTROSCOPE IN METEOROLOGY.

In April last it was thought desirable to add to the regular meteorological observation made at the Shattuck observatory, Dartmouth college, the hygrometric indications of the spectroscope. The observations were made in accordance with the directions of J. Rand Capron in his 'Plea for the rain-band.' The instruments used were two direct vision spectroscopes: one a 3½-inch 'vest-pocket' instrument of Hofmann's; the other 10 inches in length, and capable of separating the *D* lines with direct sunlight. The observations made in this way were found to be interesting, but unsatisfactory. The difficulty which an observer must always find in estimating confidently the degree of intensity of the absorption lines and bands with the widely varying lights of fair and cloudy weather, makes the arrangement of some method of measurement very desirable. After a few trials in other directions, the device described below was decided upon, and has proved satisfactory. It was thought that the absorption *lines* of aqueous vapor, seen with a spectroscope of rather high power, are better adapted to delicate measurement than the broad *band* seen with a low power. The small spectroscope used shows the dark band on the red side of the *D* line with great clearness; but the absorption lines are only visible when particularly strong. With the larger instrument, however, the spectrum is so elongated that the general darkening near *D* is hardly noticeable; while the two moisture lines to be found there are very prominent. The apparatus illustrated is designed to measure the variation in intensity of the darker line of this pair (the *a* of the *D* group of Janssen's map).

The only methods of measurement of the intensity of absorption lines, known to the writer, are those of Janssen and Gouy. The former, in 1871, in his work in mapping the atmosphere lines, used for comparison black lines of various widths, ruled on white paper, and viewed through vessels filled with darkened water.[1] Gouy made some measurements of solar lines by photometric methods; isolating a narrow strip of the spectrum adjacent to the line, and comparing its light with that of a strip of equal width containing the line. From these data he calculated the intensity of the line, not in photometric, but in linear units.[2] The method adopted by the writer is entirely different from either of these; and, as far as known, is new.

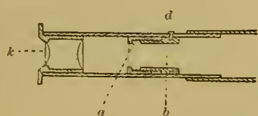


FIG. 1.

What was desired was the production of an artificial absorption spectrum, the intensity of whose lines could be varied at will, until one of the lines thus produced should be sensibly the same as the line to be measured. Fig. 1 is a section of the attachment to the spectroscope made for this purpose. The dark lines required are diffraction fringes produced at the focus of the positive eye-piece, which are therefore seen projected on the spectrum. They are produced by placing a silk fibre a little beyond the focus of the eye-piece. In the figure, the piece *a* slides in the tube, bearing with it a single silk fibre placed vertically and just in the middle of the field of view of the eye-piece. The fibre is maintained vertical by means of a projecting pin sliding in a longitudinal slot in the tube, as shown at *s* in fig. 2. The sliding motion is given to it by means of the piece *b*, which turns freely, but cannot slide, being retained by the screw *d* fitting in a groove made entirely around the piece. Two openings are made in the tube, on opposite sides, so that *b* can be turned directly with the fingers. One of these windows is shown at *n* in fig. 2. By turning in one direction, the silk fibre may be put nearly in the focus: by turning back, it can be made invisible. When near the focus, the fibre appears as a pair of dark parallel lines and quite close together. As it is drawn away from the focus, the lines appear to separate somewhat, growing constantly fainter until they disappear. The fainter diffraction fringes produced are invisible in the rather weak light of the spectrum. Whole revolutions of the screw *b* are read off on the graduation at the side of the slot, and fractions (tenths) are read from the piece itself, which is graduated as a micrometer screw. The lines thus produced resemble closely the *D* group, particularly when both are strong, when a very sharp eye is required to distinguish the spurious lines from the genuine. As the movement of the eye from side to side would modify the appearance of the interference lines, making one darker than the other, the spectrum must be viewed through a narrow vertical opening, making such motion impossible. For this purpose a piece of black paper (not shown in the figure), provided with a vertical slit of perhaps 0.7 mm. width, must be placed on the eye-lens at *k*. Even with this, a little care is necessary in the position of the eye, that the pair of lines shall always be equal. The slight darkening of the spectrum between the two lines, which occurs, is in this case not objectionable, as it imitates pretty closely the general absorption in the space between *D* and the *a* line of the *D* group. The instrument, as figured, is provided with a tangent screw at *e*, by which the whole tube containing the eye-piece can be moved horizontally, thus shifting the field of view so that any line of the spectrum can be brought to the side of the comparison lines. The instrument is mounted on a wooden base, grooved at the top to receive it. At the back side is a large knob by which the instrument is held when taking an observation. When directed to any

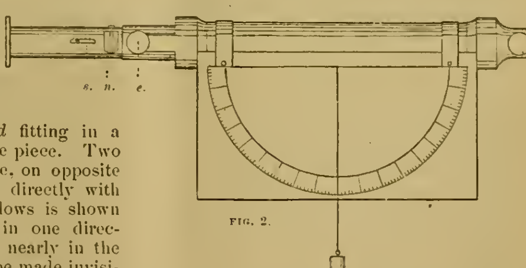


FIG. 2.

part of the sky, the altitude can be determined by means of the graduated circle and hanging weight shown in the figure.

Another device, much simpler, and of use,

[1] *Ann. phys. chim.*, xxiii. 274.
[2] *Comptes rendus*, lxxxix. 1033 and xci. 383.

it is believed, for general observation when less accuracy is required, is shown in fig. 3. A collar represented in section at *a* is inserted into the tube of the spectroscope, and fastened permanently so that its front side shall be just in the focus of the eye-piece. From the lower front edge to the upper back edge, a silk fibre passes, drawing back as it rises. The fibre will evidently appear in the field of view, as represented at *b*, as lines of diminishing intensity. A set of horizontal, equidistant spider-lines are attached to the front edge, hence just in focus. The line whose intensity is to be measured is made to appear parallel and near to one of the interference lines; and its intensity is expressed by the number of the spider-line at which the intensities correspond, counting downwards. And here it may be mentioned that such a scale of intensities (or, indeed, the scale afforded by the micrometer screw readings in the preceding apparatus) is not a scale of equal parts, a change of a unit in case of a line of high intensity being more than in case of a low intensity. This is, however, believed not to be a serious disadvantage in practice.

a Fig. 3. *b*

The advantages of any practicable method of measurement over a mere estimation are evident enough. When estimated by the eye, it is believed to be impracticable to distinguish more than five grades of strength, while by this method quite fine shades of intensity can be measured; and what is, perhaps, of equal importance, measurements made against dark and light sky are apparently identical, a change in the brilliancy of the background affecting the appearance equally of the absorption and interference lines. Evidently an unaided estimation would very likely be at fault in such a case.

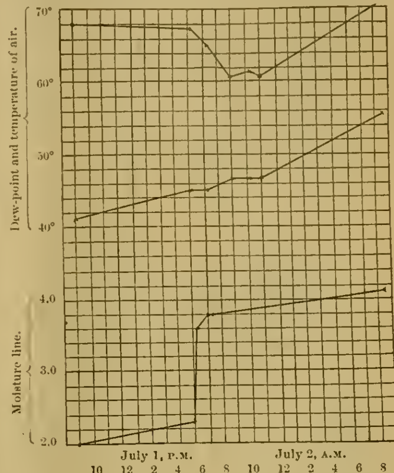
As to the accuracy actually attained in practice, it is found, in looking over the record of about a month past, that the whole range of the readings made at one observation, in ordinarily favorable weather, averages 0.3 of a revolution of the micrometer screw; and, as from four to twelve or more readings are always taken, according to the amount of variation noted, the probable error of the mean may be considered as about 0.03, as computation has shown in a number of cases. Now, as the whole range of the instrument used is from 1.0 to 5.7, it is evident that many grades of intensity are capable of appreciation. It is to be remembered, that these readings are purposely made in various quarters of the sky, so that discrepancies in readings are partly due to want of uniformity in the hygrometric state of the atmosphere. It should be stated, also, that such accuracy is not attainable below 2.0, as the value of a unit is then considerably less than above that value.

The regular record made at the observatory is as follows: The ordinary meteorological record is made three times daily. With the spectroscope, at least three sets of readings are taken, comprising measurements of the intensity of the moisture line at the horizon, at altitudes of 10°, 20°, 30°, and 90°. In all cases, the readings are taken in all quarters of the sky where there is sufficient light. A set of readings is also taken by setting the micrometer at 2.0, giving a faint line just visible in dark weather, and then measuring the altitude at which the moisture line is of the same strength. Such readings of altitude rarely vary more than 2° to 4° in settled weather. The strength of line and of the 'rain-band' is also estimated by the eye at each observation. At the same time the readings of the wet and dry bulb hygrometer are taken, as well as of a Regnault's condensing hygrometer. The wet and dry bulb hygrometer can be ventilated by means of a bellows, as suggested by Mr. H. A. Hazen, in a recent number of Science. Notes are made of the direction and velocity of the wind, of the clouds, and condition of the air.

One of the most interesting of the powers of the spectroscope thus used is its ability to detect relatively moist tracts in the atmosphere. While in settled weather entire uniformity at all points of the horizon is generally noted, in unsettled weather considerable differences are often observed. An excellent example of this power of the instrument occurred on May 26. During the morning when the observations were made, the air was very clear and dry, the moisture line therefore weak. At 6 A.M., measurements made entirely around the horizon showed that the line became invisible very uniformly at an altitude of 10°, except for about 45° of the north-eastern horizon, where the altitude of disappearance was 20°, while the intensity of the line at the horizon here was about double that elsewhere. There was no wind blowing, and no clouds of any kind were visible except a few wisps of cirrus cloud high in the east. These facts were all noted in the record at the time. At seven o'clock, when the next readings were taken, to my surprise this moist tract was found to be nearly filled up with a bank of stratus cloud, with no other clouds visible. At the same time a similar moist region, of 15° altitude and perhaps 35° length, was discovered in the south-east; and this in turn was found fifteen minutes later to be partly filled with cloud. After an hour or so they had all disappeared. The appearance was as though a body of air heavily charged with moisture, having become heated, was seen rising bodily at six o'clock, while at seven the consequent cooling had condensed in part its moisture.

One of the most striking facts noted is the suddenness with which a hygrometric change occurs, as indicated by the spectroscope. During the fine weather of June 30 and July 1, the spectroscope had indicated unusually dry air with almost absolute uniformity. During July 1, as the diagram shows, there had been a very slight increase in the moisture present, as indicated by an observation at six P.M. Fifteen minutes later, happening to glance through the spectroscope, I was greatly surprised to see how much blacker the line looked. A new set of readings was taken, giving a much higher amount of moisture, as indicated by the sudden rise in the curve. The sky was almost entirely free from clouds, with a light breeze from the south-west. Measurements were made in both cases all along the western half of the horizon, the eastern being too dark at that hour. At seven o'clock a moderately dense bank of stratus clouds had risen in the west to an altitude of 15° or 20°. The record at seven and seven-thirty showed little further hygrometric change. The sky was soon entirely overcast with clouds. This hygrometric change was not a mere momentary one, connected with cloud-formation; but the later record showed it to be the beginning of a period of moist air and showery weather. The hygrometer, it will be noted in the diagram, gave little sign of change for some hours. Other sudden changes of equally striking character have been observed. That, as has been suggested by Capron and others, the physical state of the suspended water, the size of the aqueous particles, may have an influence in its light-absorbing power, and so explain in part such changes, is very possible; but the evidence that such is the case appears to be far from conclusive.

It is believed that a series of spectroscopic observations, continued for a considerable period of time at different stations, would give much light on a number of important questions in meteorology, particularly in the study of the formation of showers and storms. The instrument is apparently admirably adapted to do this work, by its ability to trace accurately the motions of masses of vapor in the upper atmosphere. The discussion of the more important questions which arise in carry-



ing on this investigation is deferred until a larger mass of figures and facts have been accumulated. C. S. COOK.

NOTES ON SASSAFRAS-LEAVES.

THERE are three distinct forms of sassafras-leaves. The simplest is ovate, varying to oval and obovate. A second form is three-lobed, the incisions running from near the middle of the upper half of the leaf's edge to the centre of the blade. The third form is midway between the entire and three-lobed sorts, and has but one side-lobe; the opposite half of the leaf being entire. It is as if one-half of a three-lobed leaf were joined by the midrib to the opposite half of an entire one of the same size. This form may be very appropriately called the 'mitten.'

In the study of these three forms, branches of sassafras have been gathered from a large number of places through the surrounding country. Some have been obtained from the woods, and others from the open field. Branches were cut from the largest trees and from the smallest, from vigorous trees and those of slow growth. Ten hundred and fifty leaves were examined: and of these, five hundred and thirteen were entire: four hundred


4
1
2
3

and fifty-eight, three-lobed; and seventy-nine, 'mitten form.'

The first leaves of spring were invariably entire, and a lobed leaf was rarely found until the fourth leaf was passed in counting from the base of the branch toward the tip. No regular order was discovered. In one case the arrangement was as follows: three entire, four three-lobed, one 'mitten,' one three-lobed, one 'mitten,' one three-lobed, one 'mitten,' one three-lobed; on another branch, four entire, one 'mitten,' five three-lobed, one 'mitten,' three three-lobed, three 'mittens.' The leaves on short spurs of old trees were nearly all small and entire; when the branches were somewhat longer, and the leaves larger, there were one or more three-lobed or 'mitten' leaves in the middle of the stem. A number of branches taken from slow-growing trees gave the following aggregate: entire leaves, seventy: 'mittens,' six; three-lobed leaves, three. A vigorous young sprout gave twenty-seven three-lobed leaves, one 'mitten' near the middle of the stem, and no entire leaves. Another had two entire blades at the base, and twelve three-lobed leaves above. A number of these rapidly-growing young trees together gave twenty-seven entire leaves, fourteen 'mittens,' and eighty-one three-lobed leaves.

The entire and smaller leaves are in the majority on slowly-growing trees; while, on the young sprouts, larger three-lobed leaves predominate. The 'mitten' form is mostly found with the entire leaves. This form of leaf is probably about equally divided between the 'right-handed' and 'left-handed;' though, of the number found (seventy-nine), those with the 'thumb' to the left, when held with under side upward, exceeded the other sort by half. About every thirteenth leaf is a 'mitten,' — a form not found mentioned in the botanical description of the sassafras.

There seems to be no order in the arrangement of the three forms upon the branch. Leaves from the buds were examined, and all of the three forms were found. Each kind is distinct, from a very early state; and there is no indication that one ever passes into the other. No intermediate forms have been found. The venation of the three forms is very much the same. There is a midrib running lengthwise through the leaf, and a strong lateral vein on each side, which runs from near the base to beyond the middle of the leaf. Smaller veins form the framework of the middle and upper parts of the leaf. The portion of parenchyma absent in a lobed leaf is midway between the strong lateral veins. This is very clearly shown in a 'mitten,' where one side is lobed, and the other entire. It would seem as if the lobing is a failure to fill up the framework, and apparently due to a too vigorous growth of the veins, and a lack of a sufficient amount of the soft, filling tissue. In the formation of leaves the sassafras is certainly 'at loose ends,' but in this it is not alone.

Fig. 1 shows an entire sassafras-leaf; fig. 2, a three-lobed leaf; and fig. 3, a 'mitten.' Fig. 4 shows the young leaves of the three forms. All the illustrations are drawn from nature.

Byron D. Halsted.

New York, July 2, 1883.

THE UNITS OF MASS AND FORCE.

In the original definition of the gram it was regarded as a weight, and therefore a force, being the weight at the level of the sea, and at the latitude of 45°, of one cubic centimetre of water at its maximum density. It was thus virtually defined as a force. But as we shall soon see, although defined as a unit of force, it has become in practice a unit of mass. In the C. G. S. system of units this change is accepted, and the definition is modified accordingly; that is, one cubic centimetre of water is taken as the unit of mass, and this mass is called the gram without reference to its weight.

In volume i., *Cours de physique*, M. Jamin criticises this change. The high standing and character of this great work, as well as the eminence of its author, entitle his views to respectful consideration, especially as the question involves the fundamental elementary conceptions of physics in a way to render it of interest to the general student.

We set out with the proposition that what we commonly consider units of weight, such as the *kilogram* and *pound*, practically become units of mass in all the ordinary affairs of life. The reason is, that in practice bodies are weighed by balancing them against pieces of metal, and not by means of a spring balance. A pound weight is indeed heavier the farther north we go; but then, whatever we weigh with it is heavier in the same ratio. Accordingly, if by means of a weight we weigh a pound of tea at the equator, at the poles it will still weigh the same as a pound weight, although in reality heavier than at the equator. This is obviously a great practical and commercial convenience; because the quantity or mass of the tea is the important question to those who deal in it, while its gravitating force is of secondary importance. Were a perfect spring balance used which measured absolute weight, the dealer who should purchase tea at one latitude, and sell it at another, would be subject to a gain or loss, depending upon the difference in the force of gravity.

It is not, however, on merely commercial grounds that the change rests. For scientific purposes a unit is used as a term of comparison between different quantities of the same kind, and must be so defined and chosen as to fulfil this function with the greatest convenience. Now, a unit of force which shall furnish a direct and convenient standard of comparison between forces or weights at different places is entirely impracticable. At any one place the weight of a given mass of metal may be taken as a convenient unit; but this unit will change when we go to any other place, owing to the difference in the force of gravity. Indeed, every student of physics knows that the measure of the force of gravity at any one place is one of the most delicate and difficult problems in physics. In the definition which refers to the latitude of 45° it is assumed that the force of gravity is the same at all points on this parallel. We now know that this is not the case, and that if we adopt such a unit we shall have to define the exact spot on the earth's surface which is taken as the standard. Reference to such a standard would be impracticable. Hence a unit of force must be subsidiary to the unit of mass. The most convenient way of fixing it is to take the unit of mass as known, and to determine the force of gravity at the place of observation. The combination of the two gives a standard by which weight may be expressed in force. To be more explicit: if we have a piece of metal the mass of which we know to be one gram, and if we determine the force of gravity at the place to be n, then the gravitating force of that piece of metal will be known to be n units of force. In practice this must be the method used in physics, if an accurate measure of forces is really required.

Let us now consider M. Jamin's objections. He says that the mass of a body is not susceptible of direct determination; for to measure it we must commence by determining its weight in a balance, and afterwards dividing by the number which expresses the acceleration of gravity at the latitude of 45° and at the level of the sea. It is difficult to attribute this remark to any thing but inadvertence, since the division by g at 45° is necessary only on the French system. If we measure it by means of a balance having grams as weights, the resulting weight is at once the mass on the C. G. S. system, no matter where the weighing is made, and therefore needs no division whatever.

He then adds, "Suppose, on the contrary, that we have to measure a force: we determine it directly by means of weights at the place of observation. Afterwards we apply to these weights the corrections relative to the latitude and the altitude, to have an expression of the force as the function of a normal gram. We must remark that we cannot avoid these corrections to taking mass as the fundamental unit; because it is always weights that we measure, and the course followed in the experiments is necessitated by the nature of things." This is quite true, but it does not prove that one system affords any more convenient unit of force than the other.

Simon Newcomb.

STANDARD RAILWAY TIME.

The problem of simplifying the system of time standards used by the railways of this country seems to be near solution. The representatives of various railway-lines, who are to-day in session at Chicago, will receive the report of the secretary, Mr. W. F. Allen, and, it is expected, will take final action. For some years past, committees of various scientific bodies, as the American metrological society, the American association for the advancement of science, and the American society of civil engineers, have called attention to the urgent need of reform in the standards of time in use, and suggested plans for action. The railways, which are naturally most interested in the movement, have recently taken hold of the matter in earnest. The plan which has met with the most favor is that in which five standards of time, differing by consecutive hours, are proposed for the whole territory occupied by the United States and Canada. These are based upon the meridians from Greenwich, but receive other names for purposes of convenience. It is proposed by the railways that in Canada the standard shall be known as *intercolonial time*, and shall coincide with the local time on the meridian four hours, or 60°, west of Greenwich. In the United States the standards will be known as *eastern*, *central*, *mountain*, and *Pacific time*, and coincide with the local times on the meridians five, six, seven, and eight hours, or 75°, 90°, 105°, 120°, respectively, west of Greenwich. The advantage of this system is, that the standards will differ from the true local times of the various parts of the country by amounts not greater than thirty minutes, if the divisions are made rigidly according to longitude, and no one will be inconvenienced thereby. The great difficulty, however, of the plan, lies in the selection of the places where the changes of one hour are to be made; and as some of these, especially that between eastern and central time, must pass through country well settled, no matter how much freedom is allowed in selecting the points of change, it has seemed to many that the inconvenience would be great. Railway interests require that the changes be made at the termini of sections of the road, which are often large cities. At these points there will be two times, — one for eastern, one for western roads, differing by an hour. In dealing with this practical difficulty, the railways have shown a desire to conform as nearly as possible to the theoretical system, but have adopted the principles that "changes from one standard to another should be made at well-known points of departure," and that "these changes should be made at the termini of roads, where changes now occur, except on the transcontinental lines and in a few other unavoidable cases, where they can be made at the ends of divisions."

At the railway-time conventions held in St. Louis and New-York City in April last, the following resolutions were adopted: —

1°. That all roads now using Boston, New York, Philadelphia, Baltimore, Toronto, Hamilton, or Washington time as standard, or standards based upon meridians east of those points, or adjacent thereto, shall be governed by the seventy-fifth meridian or 'eastern time' (four minutes slower than New-York time).

2°. That all roads now using Columbus, Savannah, Atlanta, Cincinnati, Louisville, Indianapolis, Chicago, Jefferson City, St. Paul, or Kansas City time, or standards based upon meridians adjacent thereto, shall be run by the ninetieth meridian time, to be called 'central time' (one hour slower than 'eastern time,' and nine minutes slower than Chicago time).

3°. That west of the above-named section the roads shall be run by the one hundred and fifth and the one hundred and twentieth meridian times respectively (two and three hours slower than 'eastern time').

4°. That all changes from one hour standard to another shall be made at the termini of roads or at the ends of divisions.

Another resolution provided that the secretary should prepare a pamphlet containing an explanation of the subject, with accompanying maps, and endeavor to secure the acquiescence of all parties to the proposed plan, that the next convention might take final action.

The report of the secretary contains a fine railway-map, with the standards proposed for each road designated by different colors. It is the intention to use the eastern standard from Maine and the eastern coast to Detroit, Mich., and Bristol, Tenn.; but all the Ohio and Georgia railways will use the central standard, as well as those in Pennsylvania west of Pittsburg. The western railways whose termini are in Buffalo, Salamanca, and Charlotte, are allowed to use the central standard as far east as those points. The important places where the change of one hour from eastern to central time occurs, are Detroit, Buffalo, Pittsburg, Charlotte, and Augusta. The change from central to mountain time is made at Bismarck, North Platte, Wallace, Coolidge, and others; from mountain to Pacific time, at Ogden, Yuma, and others.

The secretary, Mr. Allen, has received assurances from the great majority of roads, that the system is approved. At the beginning of this month, railways operating 70,000 miles of road had responded favorably; and replies were coming in daily, none in the United States having refused assent. The roads centring in Boston gave assent, provided satisfactory arrangements could be made with the Cambridge observatory, upon which they depend for their time-signals. Of this there can be no doubt, as it may be assumed that every observatory in the country will contribute its part in the movement which inaugurates such a needed reform. The eastern standard differs from Boston time by sixteen minutes.

It seems almost certain, then, that the convention now in session will authorize the proposed change, and appoint a time when the plan shall be put into practical operation. On that date the observatories will make the change in their signals which the railways use, and the system will at once be under trial. The next question will be, whether the cities will adopt the railway system for their use. Of this there can be little doubt; and, in cases where two standards differing by an hour come together, it will be necessary to adopt one of the two for the city standard. The state of Connecticut, which several years ago hastily adopted New-York time for the standard, will have the small change of four minutes to authorize. All these adjustments may be left to the future. They will be made or not, as the popular interests demand. Of the wisdom of the action of the railway managers there can be no doubt. Without discussing the relative merits of the plan adopted, and others which have been suggested, it is certain that the present confused arrangement should be abolished. The new plan is simple and practicable; and its adoption is an important reform, which is deserving of hearty support and encouragement.

LETTERS TO THE EDITOR.

Phalansterium digitatum Stein.

There is no published evidence that the infusorial colony here referred to has been seen by any observer except its German discoverer. It is stated not to occur in English waters; and this uncommon animalcule had not been taken in America, until the writer recently found it in considerable profusion, attached to the leaflets of Myriophyllum from a millpond near this city. The colonies and the enclosed zoöids differ from their German relatives in no essential character, the only perceptible divergence being in the somewhat smaller size of the American Infusorium.

The tubular colonies, which take an irregular digit-like form, and branch somewhat dichotomously, are in great part built up of granular digestive rejectamenta remarkable for their coarseness. The distal extremity of each tubule is slightly inflated, each zoöid sitting singly in the hollow thus formed, except after having undergone the reproductive process, when two or more may be present, the flagellum alone extending beyond the aperture.

The conical collar, embracing the flagellum for some distance above its point of origin, is often thickened by an outward flow of the body-sarcode; but whether a regular circulation takes place in the collar substance could not be determined.

Although the zoöids are apparently entirely free from all connection with the walls of the zoocytium, they have the power of suddenly darting back into the tubules for a distance equal to two or three times their length. They seem to exercise this accomplishment at pleasure, but especially when any unwelcome object comes in contact with the flagellum. I have seen a large animalcule glide across the front of a colony, and each zoöid in regular succession, as its flagellum was touched, shoot back into the tube, remaining there some minutes before cautiously reapproaching the aperture.

I have several times witnessed the reproductive process, and have verified the statement that it takes place by transverse fission. An interesting fact in this connection is, that the only other species of the genus reproduces itself by dividing longitudinally, a method directly the opposite of that which obtains with the present form.

The two posteriorly located contractile vesicles pulsate at intervals of about thirty seconds.

Dr. Alfred C. Stokes.

Trenton, N.J.

Solar constant.

I enclose a translation of a portion of a letter to me from Dr. Josef Pernter of the Austrian meteorological service. Dr. Pernter writes: —

"Speaking of radiation, I remember to have read several times in Science, under the 'letters to the editor,' various things concerning the solar constant, — lately, a letter from John LeConte, but which, like former communications, appears to make the subject a little unclear.

"The solar constant is a quantity of heat, and the number which is the expression for the solar constant must mean calores. If, for example, Violle says the solar constant is 2.54, then it must be 2.54 calores. But since the solar radiation is a summation, during time, extending over space, the duration and the surface certainly come into the question. The minute has been taken as the unit of time, and the square centimetre as the unit of space.

"That the solar constant is 2.54 calores, means, therefore, that the sun's rays bring to the outside of our atmosphere, in each minute, 2.54 heat-units upon each square centimetre. What becomes of these heat-units, or calores, does not belong at all to the conception of the solar constant.

"The new solar constant of Langley, 2.84, signifies, consequently, that the amount of heat furnished per minute per square centimetre by solar radiation is 2.84 calores. But this number, 2.84 calores, must be comprehended. Lately the term 'calore' has been used in two significations, — the large calore, or the amount of heat that raises one kilogram of water 1°; and the small calore, or the amount of heat which raises a gram of water 1°. The latter, or small calore, is applied to the solar constant. Expressed in large calores, the solar constant of Langley would not be 2.84, but .00284 calores; that is, 1,000 times smaller.

"After these explanations, one can immediately say how many great or small calores fall upon the square metre per minute from the solar radiation; viz., 10,000 times as many as on the square centimetre."

Frank Waldo.

Deutsche seewarte, Hamburg, Germany,
Sept. 16, 1883.

Dissemination of Phlox.

I have had for some time past, on my table, some capsules of Phlox Drummondii, which is so commonly cultivated in gardens. The capsules were picked while still green, and had dried gradually. Several times I have been puzzled at finding small seeds and parts of the capsule of a plant on the table, and could not think where they came from; but, a day or so since, I heard a sharp pop, and, looking up, saw that one of the capsules had burst, and sent the seed several feet away. Since then it has often occurred. This is an evident means for the dissemination of the seed. The most of the capsules I have examined have perfected only one seed, instead of three; and the sudden opening of the capsules have sent the seeds flying far and wide.

Jos. F. James.

Cincinnati, O.

The Iroquois institutions and language.

The very courteous and complimentary manner in which my work on the Iroquois book of rites has been noticed in a recent number of this journal has made me reluctant to take exception to any portion of the review. On further consideration, however, I must beg to be allowed, in the interests of both science and history, to refer to one or two of the remarks of my friendly critic. He expresses the opinion that 'the sceptical reader' may be inclined to regard the portion of the work which relates to 'the league and its founders' rather as 'classic historical romance' than as history; and this on the sole ground (as I understand his suggestion) that the Iroquois cannot be supposed to have been capable, five hundred years agō, of the intellectual efforts implied in this narrative. This suggestion, it will be seen, opens up the entire question of the comparative mental capacity of civilized and uncivilized, or rather unlettered, races.

The question is one altogether too large to be fully discussed in this place. But as regards the particular subject now referred to, I may remark that the existence of the league itself, with all its judicious and statesmanlike regulations, is a fact of which there can be no possible question. Any one can see this remarkable constitution in full and vigorous operation among the three thousand Iroquois on their Canadian reservation. There is ample evidence to show that this league existed in its present form when the people who maintained it first became known to European explorers. It is clear, therefore, that whatever intellectual power was needed for its formation was possessed by the Iroquois before they acquired any tincture of foreign civilization.

But why should their capacity for forming such a government be questioned? The Iroquois tribes, when first known to Europeans, and doubtless for centuries before that time, were in a social stage at least as far advanced as that of our German ancestors in the days of Tacitus. We know that these barbarians, if we choose so to style them, had evolved a regular system of government, combining very ingeniously the methods of democracy and aristocracy, and comprising the germs of the English constitution. On this point the often-cited passage of Montesquieu will bear to be requoted and emphasized. "In perusing," writes the great legist, "the admirable treatise of Tacitus 'On the customs of the Germans,' we find it is from that nation the English have borrowed the idea of their political government. *This beautiful system was invented first in the woods.*" Will any one reply that the German barbarians, being of the Aryan stock, must be supposed capable of intellectual achievements which barbarians of the Indian race could not be expected to compass? I think the able and liberal-minded reviewer will agree with me, that reasoning of this 'high priori' sort, which assumes the very point in question, would be any thing but logical or satisfactory.

The reviewer is kind enough to say that many of the chapters in my volume "indicate immense research, and are of great value both ethnologically and philologically." I can assure him that equal diligence was exercised in preparing the chapters on the league and its founders, and I know of no reason why they should be deemed less accurate or less valuable. In these, moreover, as well as for the other portions of the work, I have been careful to indicate the sources of my information. Nothing will be easier than for any one who has doubts as to its correctness to repeat my inquiries, and to satisfy himself on that point. But I am happy to say that the communications which reach me from many quarters seem to show that no such doubts are likely to be entertained; at least, by any well-informed persons. Writers of the highest authority on American and Indian history receive the statements of the book as entirely authentic, and speak of it in terms too flattering for me to repeat.

Let me conclude by expressing the pleasure with which I have learned from this review that the valuable work of the excellent and indefatigable missionary-linguist, the late Father Marcoux, on the Iroquois language, is about to be published by the Bureau of ethnology. The idioms of the Huron-Iroquois group stand, perhaps, at the head of the best-known Indian languages as subjects of philosophical study. It is doubtful if even the Quichua or the Aztec equals them in comprehensive force, or in subtlety of distinctions. More than two centuries ago the learned missionary Brebeuf was struck with the resemblance of the Huron to the Greek; and in our own day Professor Max Müller, after a careful study of the Mohawk tongue, has expressed the opinion that the people who wrought out such a language 'were powerful reasoners and accurate classifiers.' The works of M. Marcoux, in conjunction with those of his distinguished pupil and successor, M. Cuoq, will afford ample means for the study of one, and perhaps the finest, of this remarkable group of languages.

In connection with this subject, it is proper to refer to the doubt expressed by the reviewer as to the correctness of the linguistic works of the French missionaries. It is suggested that they have made mistakes in grammar, and in particular that they have not been able to distinguish between the feminine and the indeterminate inflections. Now, it must be remembered that the intelligent and well-educated missionaries, whose competency is thus questioned, have for many years spoken and written the Iroquois language almost as familiarly as their native speech, and have published many books in that language for the use of their converts. Their predecessors, whose experience they have inherited, had been engaged in the same work for more than two hundred years. To suppose them so grossly ignorant of the grammar of the language as is now suggested is much the same as supposing a professor of Latin in an English or American college to be unable to distinguish between the genitive and the accusative cases in that language. If the work of Marcoux is so erroneous, it is clearly unfit to be published in a national series like that of the Ethnological bureau. In justice both to the missionaries and the bureau, I am glad to be able to show, by the best possible evidence, that the suspected errors do not exist. The Iroquois must be supposed to know their own language. The text of their Book of rites, fortunately, presents a test which is conclusive. In preparing the translation of this text, with the aid of the best native interpreters, I had occasion, as the appended glossary shows, to make constant use of the publications of M. Cuoq on the Iroquois tongue, and found them invariably correct. In particular, I may mention, the indeterminate form frequently occurs, employed precisely as indicated by him. The bureau may therefore safely add the work of M. Marcoux to the other valuable publications which have done so much credit to the scholarship of their authors and to the liberality of the government.

H. Hale.

THOMSON AND TAIT'S NATURAL PHILOSOPHY. — I.

A treatise on natural philosophy. By Sir William Thomson LL.D., D.C.L., F.R.S., and P. G. Tait, M.A. Vol. i., part ii, new edition. Cambridge, *University press*, 1883. 25+527 p. 8°.

The first edition of vol. i. (23+727 p.) of this work was published by the delegates of the Clarendon press at Oxford, 1867. The authors then intended, as appears from their preface, to complete the work in four volumes. The remaining three volumes have, however, never appeared, much to the regret of all students of mathematical physics; and the authors state that the "intention of proceeding with the other volumes is now definitely abandoned."

In 1879 a new and enlarged edition was published of a portion of vol. i., entitled part i. (17+508 p.), including that part of the first edition contained in the first 336 pages; and now we have the remainder of vol. i., entitled part ii., which has been enlarged by important additions from 390 to 527 pages.

At p. 22 will be found a schedule of the alterations and additions in part i., and, at p. 24, those of part ii. "The most important part of the labor of editing part ii. has been borne by Mr. G. H. Darwin," whose remarkable papers in the Philosophical transactions upon the mathematical physics of the earth, past and present, have placed him in the front rank of the cultivators of that science. His contributions to part ii. are duly accredited to him in the above-mentioned schedule.

The original object of this treatise is stated to be twofold; viz., "to give a tolerably complete account of what is now known of natural philosophy, in language adapted to the non-mathematical reader, and to furnish to those who have the privilege which high mathematical acquirements confer, a connected outline of the analytical processes by which the greater part of that knowledge has been extended into regions as yet unexplored by experiment."

From the nature of the case, the success of the authors in the attainment of their first object was small, compared with the second; for in order to give an intelligible account, to one unaccustomed to mathematical reasoning, of the general tenor and results of such reasoning, requires not only capacities such as few mathematicians have had in our day, except Clifford, but requires, also, an amount of space incompatible with the second and principal object which the authors had in view. In order, however, better to reach the non-mathematical reader, the authors published a work entitled 'Elements of natural philosophy, part i.,' which was only an abridgment of this 'treatise,' made by simply omitting all the advanced mathematical developments.

The second and principal object, however, of the authors, was one in which they, perhaps, were better fitted to succeed than any who could be selected. Their object was a large one, and its attainment was undertaken in a large way. It involved the presentation of the general subject of kinematics, or the geometry of motion considered apart from the forces causing it, including the exposition and use of generalized co-ordinates; and the consideration of harmonic motion, which "naturally leads to Fourier's theorem, one of the most important of all analytical results as regards usefulness in physical science," and including, also, the higher parts of the analytical discussion of curves and surfaces in space, of three dimensions. Next it required an extended development of dynamical laws and principles founded on Newton's Principia, comprising the dynamics of a particle and of a rigid body, and the whole of what is now termed kinetics worked over and "developed from the grand basis of the conservation of energy." The scope of the work demanded, also, the establishment of the principal formulae of spherical harmonics, a branch of analysis whose character we shall explain more at length hereafter.

All these and other subjects, which are usually regarded as but distantly related to the subject in hand, form a necessary part of a work whose object is as wide as that proposed by the authors. But it is hardly too much to say, that every important theory treated has received at their hands, not only elucidation, but additions of importance.

In order to make this paper as useful as may be, it has seemed best, in what follows, to content ourselves with the attempt to give an account to mathematical readers of the more important developments contained in the work, and not to engage in the task of trying to make an elucidation of its contents suitable for the general reader.

When we come to consider in particular the contents of part ii., it is found to be upon the general subject of *statics;* though many subjects, such as elasticity, the tides, etc., not usually treated in works on that subject, are here included. It consists of three chapters, the first of which is but five pages in length, and is merely introductory. It states and illustrates the utter impossibility of submitting the *exact* conditions of any physical question to mathematical investigation by reason of our ignorance of the nature of matter and molecular forces, but shows that approximate solutions obtained by neglecting forces which do not affect the conclusions sought to be established, and by regarding bodies as rigid which are nearly so, lead to practically the same results, as to the equilibrium and motion of bodies, as we should be led to by the solution of the infinitely more transcendent problem which has regard to *all* the forces acting.

In case, however, we consider the bending or other deformations of bodies regarded as elastic, we make a second approximation to the exact treatment of physical questions; and, by introducing modifications of elasticity due to changes of temperature, we should make a third approximation, which might be carried one step farther by taking account of conduction of heat, and farther still by considering the modifications of ordinary conduction due to thermo-electric currents, etc. In view of all this, the authors say, "The object of the present division of this volume (i.e., part ii.) is to deal with the first and second of these approximations. In it we shall suppose all solids either *rigid* (i.e., unchangeable in form and volume) or *elastic;* but, in the latter case, we shall assume the law connecting a compression or a distortion with the force which causes it, to have a particular form deduced from experiment. . . . We shall also suppose fluids, whether liquids or gases, to be either *compressible* or *incompressible*, according to certain known laws; and we shall omit considerations of fluid friction, although we admit the consideration of friction between solids."

The next chapter (v.) comprises pp. 6 to 100, and its especial object is set forth in the introductory section (454), as follows: "We naturally divide statics into two parts, — the equilibrium of a particle, and that of a rigid or elastic body or system of particles, whether solid or fluid. In a very few sections we shall dispose of the first of these parts, and the rest of this chapter will be devoted to a digression on the important subject of attraction." In other words, this chapter is devoted, with the exception of a couple of pages, to an extended treatment of attraction according to the law of the inverse square of the distance as applied to gravitation, electricity, and magnetism.

After a brief investigation of the usual formulae for the attraction of the spherical shell, circular disk, thin cylinder, circular arc, etc., the main subject of the chapter is reached, which is the modern mathematical theory of potential; which theory is the principal means now employed in the discussion of questions relating to the distribution of attracting matter, and the forces caused by it. This theory, due as it is to the analytical discoveries of Laplace, Green, Gauss, and others, might, nevertheless, have long remained comparatively barren of fruitful results in physics, had it not been for the genius of Faraday, who, though unskilled in the use of analysis, had a most powerful grasp of geometric and physical relations. In the words of another,[1] "Faraday, in his mind's eye, saw lines of force traversing all space, where mathematicians saw centres of force attracting at a distance; Faraday saw a medium where they saw nothing but a distance; Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they found it in a power of action at a distance." He conceived of lines of gravitational force as holding the planets in their orbits. These lines radiated through all space from the attracting body as a nucleus, regardless of the existence or non-existence of bodies upon which the attraction could be exerted. Furthermore, Faraday thought of each attracting body as surrounded at different distances by successive level surfaces, — like that of the ocean, for example, or the upper limit of the atmosphere; which surfaces cut the lines of force everywhere at right angles. This was not only true of gravitating matter, but each electrified body also had its system of lines of electrical force, and its corresponding system of level surfaces; and each magnet had its magnetic system as well. The geometry of these lines and surfaces is the basis of Faraday's reasoning in his 'Experimental researches,' and is the geometric truth hidden in the analytic discoveries clustering around Laplace's, Poisson's, and Green's theorems.

That we may call these relations more clearly before the mind, consider for a moment the so-called 'equation of continuity' of an incompressible fluid; which equation is divined from the geometric truth, that the quantity of such a fluid, which flows into any assumed closed surface, taken entirely within it, is equal to that flowing out, or that the total *flow* is *nil*. This is precisely expressed by the equation

$$\int F\,d\,S = 0, \qquad (1)$$

in which $d\ S$ is the area of the element of the assumed closed surface, F is the normal flow per square unit at that element, and the limits of integration are so taken that it extends over the entire surface. There is also another form of the equation of continuity, expressing the kinematic truth, that, in an incompressible fluid, the variations of the component velocities in the directions x, y, z, balance; i.e., their algebraic sum is *nil*, which may be written thus: —

$$\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = 0, \qquad (2)$$

in which u, v, w, are the component velocities in the directions x, y, z, respectively.

Now, it is not difficult to picture to the mind the motions occurring within the mass of an incompressible fluid; such as water, for example. In whatever way it may be moving, we can think of stream-lines along which the different parts of it flow. A number of these lines, side by side, can be taken to form a stream, and can be thought of as bounded by a kind of tubular surface; which surface might be regarded as the boundary of the stream, which isolates it from surrounding streams. If the stream has the same velocity at every point along the tube, then its cross-section must be uniform; but, where the velocity is less, the cross-section is proportionately increased, and *vice versa*. This follows from the fact that the same quantity must pass each cross-section per unit of time. A tube in which a unit of volume passes a given cross-section per unit of time is called a *unit-tube*. Now, the forces of attraction in free space, caused by any distribution of matter, electricity, or magnetism,

[1] Preface of Maxwell's Electricity and magnetism.

follow precisely the same laws as the velocities and flow of incompressible fluids; for, consider for the moment the lines of force starting from the surface of some attracting body (a magnet, for example). They gradually diverge as the distance increases, and curve away into space. Each one of these lines may be taken as the representative of a definite amount of attraction, which is the same at all points along it; and if a tubular surface be supposed to exist, including everywhere certain of these lines which lie beside each other, and no others, the total amount of force acting across every cross-section of the tube is the same: hence equations (1) and (2) apply as well to forces of attraction as to velocities of an incompressible fluid, provided F, u, v, w, be taken to be the component forces along the normal and along x, y, z, respectively, and provided that none of the attracting matter be contained within the closed surface considered in equation (1), or at the point considered in equation (2). In order to the farther development of these equations, let us compute the work which would be obtained in carrying a unit of attracted material from one given position to another. The work is found from the usual expression

$$V = - \int (u\,dx + v\,dy + w\,dz), \qquad (3)$$

in which u, v, w, being component forces, the limits of the integration are the co-ordinates of the two given points; but what path is taken between these points is of no consequence, because the amount of work depends alone upon their difference of level:

$$\therefore u = - \frac{dV}{dx}, v = - \frac{dV}{dy}, w = - \frac{dV}{dz}, \qquad (4)$$

in which the right-hand numbers are partial differential coefficients. V is evidently a function of the cö-ordinates such that its value depends upon position, and not upon the kind of co-ordinates employed. The point which fixes the lower limit of the integral in (3) is usually taken at infinity; and the value of V taken between it and the point fixing the upper limit is called the *potential* of the latter point.

By help of (3), we may put equation (1) in the form

$$\int \frac{dV}{du}\,dS = 0, \qquad (5)$$

in which du is the element of the normal to the closed surface considered.

And by substituting in (2) the values given in (4), we have,

$$\frac{d^2 V}{dx^2} + \frac{d^2 V}{dy^2} + \frac{d^2 V}{dz^2} = 0, \qquad (6)$$

which is Laplace's equation, and is often written in the abbreviated form, $\nabla^2 V = 0$. Poisson showed, that, when the point at which the potential is to be computed is within the mass of the attracting matter, the right-hand member of (6) should no longer be *nil*, but $4\pi\rho$ instead, in which ρ is the density of the matter at that point. Similarly, the right-hand member of (5) becomes $4\pi m$ when an amount of matter m is included within the closed surface considered.

Equation (6) states that V must be such a function of the co-ordinates, that, if we take its three partial second differential coefficients and add them, their sum is *nil*. What possible algebraic forms are there which fulfil this condition? They are, of course, to be found by attempting to solve the differential equation (6). But it is to be seen beforehand, from the manner in which that equation was established, that it must have an infinite number of solutions; for V must be such a function as to be capable of expressing the work to be obtained from a unit of attracted matter when brought from infinity into the presence of attracting matter, whatever its distribution in space. The function V must therefore, in general, be different for every different distribution of attracting matter.

The integration of equation (6), and the discussion of its various solutions, constitute the branch of mathematics called spherical harmonic analysis; and to it the authors have devoted pp. 171 to 219, in part i. The formulae there obtained are employed, whenever required in the present chapter, to express the potential, or the attraction of matter distributed according to laws not conveniently to be treated by less elementary methods.

As the study of spherical harmonics has been comparatively neglected in this country, a short digression, explaining some of their properties, may be useful.

From the nature of attraction, it being toward fixed centres, it appears that polar co-ordinates would be more suitable to express its relations than rectangular co-ordinates; and, in fact, equation (6) is usually transformed to polar co-ordinates in space before integration, which co-ordinates may be taken to be the radius vector, the latitude, and the longitude of the point at which the potential is computed.

It may be shown that there are two general forms of solution of this polar differential equation, — one in ascending powers of the radius vector; and the other in ascending powers of its reciprocal, with coefficients depending upon sines or cosines of the angular co-ordinates.

As these series may be broken off at any point by the vanishing of the arbitrary numerical coefficients introduced during integration, these solutions may be in terms of the radius vector of any degree, positive or negative.

It is then found that a most important and simple class of solutions, called zonal harmonics, is those which are independent of the longitude, and consequently contain but two variables, — the radius vector and the latitude.

If in any harmonic we assume some special value of the radius vector for consideration, we evidently confine our attention to a spherical surface; and the expression is then spoken of as a surface harmonic, in distinction from that in which the radius vector is a variable, in which case it is called a solid harmonic.

On the surface of a sphere of given radius, it is possible to suppose the values of a surface-harmonic to be laid off graphically along the radii to each point, toward or away from the centre, according to their sign. This will give a picture to the mind of the distribution of the surface-harmonic.

Now, in a zonal harmonic of the first positive degree (which varies as the sine of the latitude) the surface-distribution is all positive on one side of the equator, and all negative on the other. A simple zonal harmonic of the second degree has a distribution like that included between a nearly spherical ellipsoid of revolution about the polar axis and a sphere when the two intersect along two parallels of latitude. The ellipsoid may be prolate or oblate. The number of zones depends, in any case, upon the degree of the zonal harmonic, and is such that the number of parallels of latitude at which the distribution changes sign is the same as the degree; and they are symmetrically situated about the equator, so that in the odd degrees the equator is itself such a parallel.

There are other solutions, called sectorial harmonics, in which the surface-distribution changes sign at equidistant meridians, and other solutions still, which are a combination of these two, called tesseral harmonics, in which the sign of the distribution changes, checker-board fashion, at parallels and meridians. The sectorial harmonics are, however, in reality, nothing more than the combination of a number of zonal harmonics of the same degree, whose poles are situated at equal distances along the equator; and the tesseral harmonics are combinations of the sectorial with the zonal harmonics. Indeed, the most general harmonic is one by means of which any surface-distribution whatever may be expressed by properly determining the constant coefficients, and is merely a combination of zonal harmonics superposed one upon another, with poles situated in some irregular manner upon the surface of the sphere. This brings us to the fundamental theorem stated in section 537, upon which the special importance and usefulness of these functions rest, — "A spherical harmonic distribution of density (i.e., matter) on a spherical surface produces a similar and similarly placed spherical harmonic distribution of potential over every concentric spherical surface through space, external and internal; and so, also, consequently, of radial component force. . . . The potential is, of course, a solid harmonic through space, both external and internal; and is of positive degree in the internal, and of negative degree in the external space," as is evidently necessary, if the series expressing the potential in these two cases are to converge. When we come to treat in the same equation the potentials of a given point due to two different bodies, or systems of bodies, a remarkable relation is found to exist between them, called, from its discoverer, Green's theorem, which, though somewhat complicated when expressed in rectangular co-ordinates, has been put by Maxwell in a simple form, which may be written

$$\int V_1 dm_2 = \int V_2 dm_1, \qquad (7)$$

in which the subscripts refer to the first and second systems respectively, and the integrations are to be extended so as to include the total masses m_1 and m_2 respectively of the two systems. Laplace's and Poisson's equations are, of course, particular cases of Green's theorem. Thomson has effected an important extension of Green's theorem, given on pp. 167 to 171, part i. Constant references are made to these theorems, not only as to their direct application, as we have presented it, but in their application to the inverse question of determining what the distribution of matter must be to produce a given distribution of potential.

The most extended and important application of the theories of attraction and potential treated in this chapter is that of ellipsoids and ellipsoidal shells, — a subject which is closely connected with that of the figure of the earth, and one which has engaged the prolonged attention of many of the most powerful mathematical intellects of the past. A full account of the course of discovery in this field is found in Todhunter's History of the theories of attraction and figure of the earth, 2 vols.

Ten pages of new matter (pp. 40–50) have been inserted in this edition, embracing modern investigations of importance on this subject.

(*To be continued.*)

OBLIGATIONS OF MATHEMATICS TO PHILOSOPHY, AND TO QUESTIONS OF COMMON LIFE.[1] — II.

I SAID that I would speak to you, not of the utility of the mathematics in any of the questions of common life or of physical science, but rather of the obligations of mathematics to these different subjects. The consideration which thus presents itself is, in a great measure, that of the history of the development of the different branches of mathematical science in connection with the older physical sciences, — astronomy and mechanics. The mathematical theory is, in the first instance, suggested by some question of common life or of physical science, is pursued and studied quite independently thereof, and perhaps, after a long interval, comes in contact with it, or with quite a different question. Geometry and algebra must, I think, be considered as each of them originating in connection with objects or questions of common life, — geometry, notwithstanding its name, hardly in the measurement of land, but rather from the contemplation of such forms as the straight line, the circle, the ball, the top (or sugar-loaf). The Greek geometers appropriated for the geometrical forms corresponding to the last two of these the words σφαῖρα and κῶνος, our sphere and cone; and they extended the word 'cone' to mean the complete figure obtained by producing the straight lines of the surface both ways indefinitely. And so algebra would seem to have arisen from the sort of easy puzzles in regard to numbers which may be made, either in the picturesque forms of the Bija-Ganita, with its maiden with the beautiful locks, and its swarms of bees amid the fragant blossoms, and the one queen-bee left humming around the lotus-flower; or in the more prosaic form in which a student has presented to him in a modern text-book a problem leading to a simple equation.

The Greek geometry may be regarded as beginning with Plato (B.C. 430–347). The notions of geometrical analysis, loci, and the conic sections, are attributed to him; and there are in his 'Dialogues' many very interesting allusions to mathematical questions, — in particular the passage in the 'Theaetetus' where he affirms the incommensurability of the sides of certain squares. But the earliest extant writings are those of Euclid (B.C. 285). There is hardly any thing in mathematics more beautiful than his wondrous fifth book; and he has also, in the seventh, eighth, ninth, and tenth books, fully and ably developed the first principles of the theory of numbers, including the theory of incommensurables. We have next Apollonius (about B.C. 247) and Archimedes (B.C. 287–212), both geometers of the highest merit, and the latter of them the founder of the science of statics (including therein hydrostatics). His dictum about the lever, his 'Εὕρηκα,' and the story of the defence of Syracuse, are well known. Following these we have a worthy series of names, including the astronomers Hipparchus (B.C. 150) and Ptolemy (A.D. 125), and ending, say, with Pappus (A.D. 400), but continued by their Arabian commentators, and the Italian and other European geometers of the sixteenth century and later, who pursued the Greek geometry.

The Greek arithmetic was, from the want of a proper notation, singularly cumbrous and difficult; and it was, for astronomical purposes, superseded by the sexagesimal arithmetic, attributed to Ptolemy, but probably known before his time. The use of the present so-called Arabic figures became general among Arabian writers on arithmetic and astronomy about the middle of the tenth century, but it was not introduced into Europe until about two centuries later. Algebra, among the Greeks, is represented almost exclusively by the treatise of Diophantus (A.D. 150), — in fact, a work on the theory of numbers, containing questions relating to square and cube numbers, and other properties of numbers, with their solutions. This has no historical connection with the later algebra introduced into Italy from the east by Leonardi Bonacci of Pisa (A.D. 1202–1208), and successfully cultivated in the fifteenth and sixteenth centuries by Lucas Paciolus, or de Burgo, Tartaglia, Cardan, and Ferrari. Later on, we have Vieta (1540–1603), Harriot, already referred to, Wallis, and others.

Astronomy is, of course, intimately connected with geometry. The most simple facts of observation of the heavenly bodies can only be *stated* in geometrical language; for instance, that the stars describe circles about the Pole-star, or that the different positions of the sun among the fixed stars in the course of the year form a circle. For astronomical calculations it was found necessary to determine the arc of a circle by means of its chord. The notion is as old as Hipparchus, a work of whom is referred to as consisting of twelve books on the chords of circular arcs. We have (A.D. 125) Ptolemy's 'Almagest,' the first book of which contains a table of arcs and chords, with the method of construction; and among other theorems on the subject, he gives there the theorem, afterwards inserted in Euclid (book vi. prop. D), relating to the rectangle contained by the diagonals of a quadrilateral inscribed in a circle. The Arabians made the improvement of using, in place of the chord of an arc, the sine, or half-chord of double the arc, and so brought the theory into the form in which it is used in modern trigonometry. The before-mentioned theorem of Ptolemy, — or, rather, a particular case of it, — translated into the notation of sines, gives the expression for the sine of the sum of two arcs in terms of the sines and cosines of the component arcs, and it is thus the fundamental theorem on the subject. We have in the fifteenth and sixteenth centuries a series of mathematicians, who, with wonderful enthusiasm and perseverance, calculated tables of the trigonometrical or circular functions, — Purbach, Müller or Regiomontanus,

[1] Address of Professor CAYLEY before the British association. Concluded from No. 35.

Copernicus, Reinhold, Maurolycus, Vieta, and many others. The tabulations of the functions tangent and secant are due to Reinhold and Maurolycus respectively.

Logarithms were invented, not exclusively with reference to the calculation of trigonometrical tables, but in order to facilitate numerical calculations generally. The invention is due to John Napier of Merchiston, who died in 1618, at sixty-seven years of age. The notion was based upon refined mathematical reasoning on the comparison of the spaces described by two points; the one moving with a uniform velocity, the other with a velocity varying according to a given law. It is to be observed that Napier's logarithms were nearly, but not exactly, those which are now called, sometimes Napierian, but more usually hyperbolic logarithms, those to the base e; and that the change to the base 10 (the great step by which the invention was perfected for the object in view) was indicated by Napier, but actually made by Henry Briggs, afterwards Savilian professor at Oxford (d. 1630). But it is the hyperbolic logarithm which is mathematically important. The direct function e^x, or exp. x, which has for its inverse the hyperbolic logarithm, presented itself, but not in a prominent way. Tables were calculated of the logarithms of numbers, and of those of the trigonometrical functions.

The circular function and the logarithm were thus invented each for a practical purpose, separately, and without any proper connection with each other. The functions are connected through the theory of imaginaries, and form together a group of the utmost importance throughout mathematics: but this is mathematical theory; the obligation of mathematics is for the discovery of the functions.

Forms of spirals presented themselves in Greek architecture, and the curves were considered mathematically by Archimedes. The Greek geometers invented some other curves more or less interesting, but recondite enough in their origin. A curve which might have presented itself to anybody, that described by a point in the circumference of a rolling carriage-wheel, was first noticed by Mersenne in 1615, and is the curve afterwards considered by Roberval, Pascal, and others, under the name of the roulette, otherwise the cycloid. Pascal (1623–62) wrote, at the age of seventeen, his 'Essais pour les coniques' in seven short pages, full of new views on these curves, and in which he gives, in a paragraph of eight lines, his theory of the inscribed hexagon.

Kepler (1571–1630), by his empirical determination of the laws of planetary motion, brought into connection with astronomy one of the forms of conic, the ellipse, and established a foundation for the theory of gravitation. Contemporary with him for most of his life, we have Galileo (1564–1642), the founder of the science of dynamics; and closely following upon Galileo, we have Isaac Newton (1643–1727). The 'Philosophiae naturalis principia mathematica,' known as the 'Principia,' was first published in 1687.

The physical, statical, or dynamical questions which presented themselves before the publication of the 'Principia' were of no particular mathematical difficulty; but it is quite otherwise with the crowd of interesting questions arising out of the theory of gravitation, and which, in becoming the subject of mathematical investigation, have contributed very much to the advance of mathematics. We have the problem of two bodies, or, what is the same thing, that of the motion of a particle about a fixed centre of force, for any law of force; we have also the problem (mathematically very interesting) of the motion of a body attracted to two or more fixed centres of force; then, next preceding that of the actual solar system, the problem of three bodies. This has ever been and is far beyond the power of mathematics; and it is in the lunar and planetary theories replaced by what is mathematically a different problem, — that of the motion of a body under the action of a principal central force and a disturbing force, — or, in one mode of treatment, by the problem of disturbed elliptic motion. I would remark that we have here an instance in which an astronomical fact, the observed slow variation of the orbit of a planet, has directly suggested a mathematical method, applied to other dynamical problems, and which is the basis of very extensive modern investigations in regard to systems of differential equations. Again: immediately arising out of the theory of gravitation, we have the problem of finding the attraction of a solid body of any given form upon a particle, solved by Newton in the case of a homogeneous sphere, but which is far more difficult in the next succeeding cases of the spheroid of revolution (very ably treated by Maclaurin), and of the ellipsoid of three unequal axes. There is, perhaps, no problem of mathematics which has been treated by so great a variety of methods, or has given rise to so much interesting investigation, as this last problem of the attraction of an ellipsoid upon an interior or exterior point. It was a dynamical problem, that of vibrating strings, by which Lagrange was led to the theory of the representation of a function as the sum of a series of multiple sines and cosines; and connected with this we have the expansions in terms of Legendre's functions P_n, suggested to him by the question, just referred to, of the attraction of an ellipsoid. The subsequent investigations of Laplace, on the attractions of bodies differing slightly from the sphere, led to the functions of two variables called Laplace's functions. I have been speaking of ellipsoids; but the general theory is that of attractions, which has become a very wide branch of modern mathematics. Associated with it, we have in particular the names of Gauss, Lejeune-Dirichlet, and Green; and I must not omit to mention that the theory is now one relating to n-dimensional space. Another great problem of celestial mechanics, that of the motion of the earth about its centre of gravity (in the most simple case, that of a body not acted upon by any forces), is a very interesting one in the mathematical point of view.

I may mention a few other instances where a practical or physical question has connected itself with the development of mathematical theory. I have spoken of two map projections, — the stereographic, dating from Ptolemy; and Mercator's projection, invented by Edward Wright about the year 1600. Each of these, as a particular case of the orthomorphic projection, belongs to the theory of the geometrical representation of an imaginary variable. I have spoken also of perspective, and (in an omitted paragraph) of the representation of solid figures employed in Monge's descriptive geometry. Monge, it is well known, is the author of the geometrical theory of the curvature of surfaces, and of curves of curvature. He was led to this theory by a problem of earthwork, — from a given area, covered with earth of uniform thickness, to carry the earth and distribute it over an equal given area with the least amount of cartage. For the solution of the corresponding problem in solid geometry, he had to consider the intersecting normals of a surface, and so arrived at the curves of curvature (see his 'Mémoire sur les déblais et les remblais,' *Mém. de l'acad.*, 1781). The normals of a surface are, again, a particular case of a doubly infinite system of lines, and are so connected with the modern theories of congruences and complexes.

The undulatory theory of light led to Fresnel's wave-surface, — a surface of the fourth order, by far the most interesting one which had then presented itself. A geometrical property of this surface, that of having tangent planes, each touching it along a plane curve (in fact, a circle), gave to Sir W. R. Hamilton the theory of conical refraction. The wave-surface is now regarded in geometry as a particular case of Kummer's quartic surface, with sixteen conical points and sixteen singular tangent planes.

My imperfect acquaintance, as well with the mathematics as the physics, prevents me from speaking of the benefits which the theory of partial differential equations has received from the hydrodynamical theory of vortex motion, and from the great physical theories of electricity, magnetism, and energy.

It is difficult to give an idea of the vast extent of modern mathematics. This word 'extent' is not the right one: I mean extent crowded with beautiful detail, — not an extent of mere uniformity, such as an objectless plain, but of a tract of beautiful country seen at first in the distance, but which will bear to be rambled through, and studied in every detail of hillside and valley, stream, rock, wood, and flower. But as for any thing else, so for a mathematical theory, — beauty can be perceived, but not explained. As for mere extent, I might illustrate this by speaking of the dates at which some of the great extensions have been made in several branches of mathematical science.

And, in fact, in the address as written, I speak at considerable length of the extensions in geometry since the time of Descartes, and in other specified subjects since the commencement of the century. These subjects are the general theory of the function of an imaginary variable; the leading known functions, viz., the elliptic and single theta-functions and the Abelian and multiple theta-functions; the theory of equations and the theory of numbers. I refer also to some theories outside of ordinary mathematics, — the multiple algebra, or linear associative algebra, of the late Benjamin Peirce; the theory of Argand, Warren, and Peacock, in regard to imaginaries in plane geometry; Sir W. R. Hamilton's quaternions; Clifford's biquaternions; the theories developed in Grassmann's 'Ausdehnungslehre,' with recent extensions thereof to non-Euclidian space by Mr. Homersham Cox; also Boole's 'Mathematical logic,' and a work connected with logic, but primarily mathematical and of the highest importance, Shubert's 'Abzählende geometrie' (1878). I remark that all this in regard to theories outside of ordinary mathematics is still on the text of the vast extent of modern mathematics.

In conclusion, I would say that mathematics have steadily advanced from the time of the Greek geometers. Nothing is lost or wasted. The achievements of Euclid, Archimedes, and Apollonius, are as admirable now as they were in their own days. Descartes' method of co-ordinates is a possession forever. But mathematics has never been cultivated more zealously and diligently, or with greater success, than in this century, — in the last half of it, or at the present time. The advances made have been enormous. The actual field is boundless, the future full of hope. In regard to pure mathematics we may most confidently say, —

> "Yet I doubt not through the ages one increasing purpose runs,
> And the thoughts of men are widened with the process of the suns."

THE ENDOWMENT OF BIOLOGICAL RESEARCH.[1]

It has become the custom for the presidents of the various sections of this association to open the proceedings of the departments with the chairmanship of which they are charged by formal addresses. In reflecting on the topics which it might be desirable for me to bring under your notice, as your president, on the present occasion, it has occurred to me that I might use this opportunity most fitly by departing somewhat from the prevailing custom of reviewing the progress of science in some special direction during the past year, and that, instead of placing before you a summary of the results recently obtained by the investigations of biologists in this or that line of inquiry, I might ask your attention, and that of the external public (who are wont to give some kindly consideration to the opinions expressed on these occasions) to a matter which is even more directly connected with the avowed object of our association; namely, 'the advancement of science.' I propose to place before you a few observations upon the provision which exists in this country for the advancement of that branch of science to which section D is dedicated; namely, biology.

I am aware that it is usual for those who speak of men of science and their pursuits to ignore altogether such sordid topics as the one which I have chosen to bring forward. A certain pride, on the one hand, and a willing acquiescence, on the other hand, usually prevent those who are professionally concerned with

[1] An address to the biological section of the British association. By Prof. E. Ray Lankester, M.A., F.R.S., F.L.S., president of the section. From advance copy kindly furnished by the editor of *Nature*.

scientific pursuits from exposing to the public the pecuniary destitution, and the consequent crippling and languor, of scientific research in this country. Those Englishmen who take an interest in the progress of science are apt to suppose, that, in some way which they have never clearly understood, the pursuit of scientific truth is not only its own reward, but also a sufficient source of food, drink, and clothing. Whilst they are interested and amused by the remarkable discoveries of scientific men, they are astonished whenever a proposal is mentioned to assign salaries to a few such persons, sufficient to enable them to live decently whilst devoting their time and strength to investigation. The public are becoming more and more anxious to have the opinion or report of scientific men upon matters of commercial importance, or in relation to the public health: and yet, in ninty-nine cases out of a hundred, they expect to have that opinion for the asking, although accustomed to pay other professional men handsomely for similar service. There is, it appears, in the public mind, a vague belief that men who occupy their time with the endeavor to add to knowledge in this or that branch of science are mysteriously supported by the state exchequer. and are thus fair game for attacking with all sorts of demands for gratuitous service; or, on the other hand, the notion at work appears sometimes to be, that the making of new knowledge — in fact, scientific discovery — is an agreeable pastime, in which some ingenious gentlemen, whose business in other directions takes up their best hours, find relaxation after dinner or on the spare hours of Sunday. Such mistaken views ought to be dispelled with all possible celerity and determination. It is in part owing to the fact that the real state of the case is not widely and persistently made known to the public, that no attempt is made in this country to raise scientific research, and especially biological research, from the condition of destitution and neglect under which it suffers, — a condition which is far below that of these same interests in France and Germany, and even in Holland, Belgium, Italy, and Russia, and is discreditable to England in proportion as she is richer than other states.

It appears to me, that, in placing this matter before you, I may remove myself from any suggestion of self-interest by at once stating that the great defect to which I shall draw your attention is, *not* that the few existing public positions which are open in this country to men who intend to devote their chief energies to biological research are endowed with insufficient salaries, but that there is not any thing like *a sufficiently large number* of those posts, and that there is in that respect, from a national point of view, a pecuniary starvation of biology, a withholding of money, which (to use another metaphor) is no less the sinews of the war of science against ignorance than of other less glorious campaigns. Surely, men engaged in the scientific profession may advocate the claim of science to maintenance and needful pecuniary provision. It seems to me that we should, if necessary, swallow, rather than be controlled by, that pride which tempts us to paint the scientific career as one far above and independent of pecuniary considerations: whereas all the while we know that knowledge is languishing, that able men are drawn off from scientific research into other careers, that important discoveries are approached and their final grasp relinquished, that great men depart, and leave no disciples or successors, simply for want of that which is largely given in other countries, — of that which is most abundant in this country, and is so lavishly expended on armies and navies, on the development of commercial resources, on a hundred injurious or meaningless charities, — viz., money.

I have no doubt that I have the sympathy of all my hearers in wishing for more extensive provision in this country for the prosecution of scientific research, and especially of biological research. I need hardly remind this audience of the almost romantic history of some of the great discoveries which have been made in reference to the nature and history of living things during the past century. The microscope, which was a drawing-room toy a hundred years ago, has, in the hands of devoted and gifted students of nature, been the means of giving us knowledge which, on the one hand, has saved thousands of surgical patients from terrible pain and death, and, on the other hand, has laid the foundation of that new philosophy with which the name of Darwin will forever be associated. When Ehrenberg, and, later, Dujardin, described and figured the various forms of Monas, Vibrio, Spirillum, and Bacterium, which their microscopes revealed to them, no one could predict that fifty years later these organisms would be recognized as the cause of that dangerous suppuration of wounds which so often defeated the beneficent efforts of the surgeon, and made an operation in a hospital-ward as dangerous to the patient as residence in a plague-stricken city. Yet this is the result which the assiduous studies of the biologists, provided with laboratories and maintenance by continental states, have in due time brought to light. Theodore Schwann, professor at Liége, first showed that these bacteria are the cause of the putrefaction of organic substances; and subsequently, the French chemist Pasteur, professor in the École normale of Paris, confirmed and extended Schwann's discovery, so as to establish the belief that all putrefactive changes are due to such minute organisms, and that, if these organisms can be kept at bay, no putrefaction can occur in any given substance.

It was reserved for our countryman, Joseph Lister, to apply this result to the treatment of wounds, and, by his famous antiseptic method, to destroy by means of special poisons the putrefactive organisms which necessarily find their way into the neighborhood of a wound, or of the surgeon's knife and dressings, and to ward off by similar means the access of such organisms to the wounded surface. The amount of death, not to speak of the suffering short of death, which the knowledge of bacteria gained by the microscope has thus averted, is incalculable.

Yet, further, the discoveries of Ehrenberg, Schwann, and Pasteur, are bearing fruit of a similar kind in other directions. It seems in the highest degree probable that the terrible scourge known as tubercular consumption, or phthisis, is due to a parasitic bacterium (Bacillus) discovered two years since by Koch of Berlin as the immediate result of investigations which he was commissioned to carry on at the public expense, in the specially erected laboratory of public health, by the German imperial government. The diseases known as erysipelas and glanders (or farcy) have similarly, within the past few months in German state-supported laboratories, been shown to be due to the attacks of special kinds of bacteria. At present this knowledge has not led to a successful method of combating those diseases, but we can hardly doubt that it will ultimately do so. We are warranted in this belief by the fact that the disease known as 'splenic fever' in cattle, and 'malignant pustule,' or anthrax, in man, has likewise been shown to be due to the action of a special kind of bacterium, and that this knowledge has, in the hands of MM. Toussaint and Pasteur, led to a treatment, in relation to this disease, similar to that of vaccination in relation to small-pox. By cultivation a modified growth of the anthrax parasite is obtained, which is then used in order to inoculate cattle and sheep with a mild form of the disease, such inoculation having the result of rendering the cattle and sheep free from the attacks of the severe form of disease, just as vaccination or innoculation with cow-pox protects man from the attack of the deadly small-pox. One other case I may call to mind, in which knowledge of the presence of bacteria as the cause of disease has led to successful curative treatment. A not uncommon affliction is inflammation of the bladder, accompanied by ammoniacal decomposition of the urine. Microscopical investigation has shown that this ammoniacal decomposition is entirely due to the activity of a bacterium. Fortunately, this bacterium is at once killed by weak solutions of quinine, which can be injected into the bladder without causing any injury or irritation. This example appears to have great importance; because it is the fact that many kinds of bacteria are not killed by solutions of quinine, but require other and much more irritant poisons to destroy their life, which could not be injected into the bladder without causing disastrous effects. Since some bacteria are killed by one poison, and some by another, it becomes a matter of the keenest interest to find out all such poisons; and possibly among them may be some which can be applied so as to kill the bacteria which produce phthisis, erysipelas, glanders, anthrax, and other scourges of humanity, whilst not acting injuriously upon the body of the victim in which these infinitesimal parasites are doing their deadly work. In such ways as this, biology has turned the toy 'magnifying-glass' of the last century into a saver of life and health.

No less has the same agency revolutionized the thoughts of men in every branch of philosophy and speculation. The knowledge of the growth of the chick from the egg, and of other organisms from similarly constituted beginnings, has been slowly and continuously gained by prodigious labor, extending over generation after generation of students who have occupied the laboratories, and lived on the stipends, provided by the governments of European states, — not English, but chiefly German. It is this history of the development of the individual animal and plant from a simple homogeneous beginning to a complex heterogeneous adult, which has furnished the starting-point for the wide-reaching doctrine of evolution. It is this knowledge, coupled with the knowledge of the myriad details of structure of all kinds of animals and plants, which the faithful occupants of laboratories, and the guardians of biological collections, have, in the past hundred years, laboriously searched out, and recorded. It is this which enabled Darwin to propound, to test, and to firmly establish his theory of the origin of species by natural selection, and finally to bring the origin, development, and progress of man also into the area of physical science. I have said enough, in referring only to two very diverse examples of the far-reaching consequences flowing from the discoveries of single-minded investigators in biological science, to remind my hearers that in the domain of biology, as in other sciences, the results attained by those who have labored simply to extend our knowledge of the structure and properties of living things, in the faith that every increase of knowledge will ultimately bring its blessing to humanity, have, in fact, led with astonishing rapidity to conclusions affecting most profoundly both the bodily and the mental welfare of the community.

We who know the beneficent results which must flow more and more from the labors of those who are able to create new knowledge of living things, or, in other words, are able to aid in the growth of biological science, must feel something more than regret, — even indignation, — that England should do so small a proportion of the laborious investigation which is necessary, and is being carried on for our profit by other nationalities. It must not be supposed, because we have had our Harvey and our Darwin, our Hunter and our Lister, that therefore we have done, and are doing, all that is needful in the increase of biological science. The position of this country in relation to the progress of science is not to be decided by the citation of great names.

We require to look more fully into the matter than this. The question is, not whether England has produced some great discoverers, or as many as any other nationality, but whether we might not, with advantage to our own community and that of the civilized world generally, do far more in the field of scientific investigation than we do.

It may be laid down as a general proposition, to which I know of no important exception, that scientific discovery has only been made by one of two classes of men; namely, (1) those whose time could be devoted to it in virtue of their possessing inherited fortunes; (2) those whose time could be devoted to it in virtue of their possessing a stipend or endowment especially assigned to them for that purpose.

Now, it is a very remarkable fact that in England, far more than in any other country, the possessors of private fortunes have devoted themselves to scientific investigation. Not only have we, in all parts of the country, numerous *dilettanti*,[1] who, especially in various branches of biology, do valuable work in continually adding to knowledge, quietly pursuing their favorite study without seeking to reach to any great eminence, but it is the fact that many of the greatest names of English discoverers in science are those of men who held no professional position designed to maintain an investigator, but owed their opportunity simply to the fact that they enjoyed a more or less ample income by inheritance. Thus, Harvey possessed a private fortune, Darwin also, and Lyell. Such, also, is true of some of the English naturalists, who more recently have most successfully devoted their energies to research. Those who wish to defend the present neglect of the government and of public institutions to provide means for the carrying on of scientific research in this country are accustomed to declare as a justification for this neglect, that we do very well without such provision, inasmuch as the cultivation of science here flourishes in the hands of those who are in a position of pecuniary independence. The reply to this is obvious. If those few of our countrymen who by accident are placed in an independent position show such ability in the prosecution of scientific research, how much more would be effected in the same direction, were the machinery provided to enable those also who are *not* accidentally favored by fortune to enter upon the same kind of work! The number of wealthy men who have distinguished themselves in scientific research in England is simply evidence that there is a natural ability and liking for such work in the English character, and is a distinct encouragement to those who have it in their power to do so, to offer the opportunity of devoting themselves to research to a larger number of the members of the community. It is impossible to doubt that there are hundreds of men amongst us who have as great capacity for scientific discovery as those whom fortune has favored with leisure and opportunity. It cannot be doubted, that, were the means provided to enable even a proportion of such men to give themselves up to scientific investigation, great discoveries, of no less importance to the world than those relative to the causes of disease, and the development of living things from the egg, — which I have cited, — would be made as a direct consequence of their activity; whereas now we must wait until, in due course of time, these discoveries shall be made for us in the laboratories of Germany, France, or Russia.

It should further be pointed out, that it is altogether a mistake to suppose that the existence amongst us of a few very eminent men is any evidence that we are contributing largely to the hard work of careful study and observation, which really forms the material upon which the conclusions of eminent discoverers are based. You will find in every department of biological knowledge, that the hard work of investigation is being carried on by the well-trained army of German observers. Whether you ask the zoölogist, the botanist, the physiologist, or the anthropologist, you will get the same answer: it is to German sources that he looks for new information; it is in German workshops that discoveries, each small in itself, but gradually leading up to great conclusions, are daily being made. To a very large extent, the business of those who are occupied with teaching or applying biological science in this country consists in making known what has been done in German laboratories. Our English students flock to Germany to learn the methods of scientific research; and to such a state of weakness is English science reduced, for want of proper nurture and support, that, even on some of the rare occasions when a capable investigator of biological problems has been required for the public service, it has been necessary to obtain the assistance of a foreigner trained in the laboratories of Germany.

Let me now briefly explain what are the arrangements, in number and in kind, which exist in other countries, for the purpose of promoting the advancement of biological science, which are wanting in this country.

In the German empire, with a population of 45,000,000, there are twenty-one universities. These universities are very different from any thing which goes by the name in this country. Amongst its other arrangements, devoted to the study and teaching of all branches of learning and science, each university has five institutes, or establishments, devoted to the prosecution of researches in biological science. These are respectively the physiological, the zoölogical, the anatomical, the pathological, and the botanical. In one of these universities of average size, each of the institutes named consists of a spacious building containing many rooms fitted as workshops, provided with instruments, a museum, and, in the last instance, with an experimental garden. All this is provided and maintained by the state. At the head of each institute is the university professor respectively of physiology, of zoölogy, of anatomy, of pathology, or of botany. He is paid a stipend by the state, which, in the smallest university, is as low as £120, but may be in others as much as £700, and averages, say, £400 a year. Considering the relative expenditure of the professional classes in the two countries, this average may be taken as equal to £800 a year in England.[1] Besides the professor, each institute has attached to it, with salaries paid by the state, two qualified assistants, who, in course of time, will succeed to independent positions. A liberal allowance is also made to each institute, by the state, for the purchase of instruments, material for study, and for the pay of servants; so that the total expenditure on professor, assistants, laboratory service, and

[1] I use this word in its best and truest sense, and would refer those who have been accustomed to associate with it some implication of contempt to the wise and appreciative remarks of Goethe on 'dilettanti.'

[1] From the fact that the salaries of judges, civil servants, military and naval officers, parsons, and schoolmasters, as also the fees of physicians and lawyers, are in Germany even less than half what is paid to their representatives in England, I think that we are justified in making this estimate.

maintenance, averages £800 a year for each institute, reaching as much as £2,000 or £3,000 a year in the larger universities. It is the business of the professor, in conjunction with his assistants and the advanced students, who are admitted to work in the laboratories free of charge, to carry on investigations, *to create new knowledge* in the several domains of physiology, zoölogy, anatomy, pathology, and botany. It is for this that the professor receives his stipend, and it is on his success in this field of labor that his promotion to a more important or better paid post in another university depends. In addition to and irrespective of this part of his duties, each professor is charged with the delivery of courses of lectures, and of elementary instruction to the general students of the university; and for this he is allowed to charge a certain fee to each student, which he receives himself. The total of such fees may, in the case of a largely attended university and a popular subject, form a very important addition to the professorial income; but it is distinctly to be understood that such payment by fees is only an *addition* to the professor's income, quite independent of his stipend, and of his regular occupation in the laboratory: it is paid from a separate source, and for a separate object. There are thus in the German empire more than 100 such institutes devoted to the prosecution of biological discovery, carried on at an annual cost to the state of about £80,000, equal to about £160,000 in England, providing posts of graduated value for 300 investigators, some of small value, sufficient to carry the young student through the earlier portion of his career, whilst he is being trained and acting as the assistant of more experienced men; others forming the sufficient but not too valuable prizes which are the rewards of continuous and successful labor.

In addition to these university institutes, there are in Germany such special laboratories of research, with duly salaried staff of investigators, as the Imperial sanitary institute of Berlin, and the large museums of Berlin, Bremen, and other large towns, corresponding to our own British museum of natural history.

Moreover, we must be careful to note, in making any comparison with the arrangements existing in England, that there are, in addition to the universities in Germany, a number of other educational institutions, at least equal in number, which are known as polytechnic schools, technical colleges, and agricultural colleges. These furnish posts of emolument to a limited number of biological students, who give courses of instruction to their pupils; but they have not the same arrangements for research as the universities, and are closely similar to those colleges which have been founded of late years in the provincial towns of England, such as Bristol, Nottingham, and Leeds. The latter are sometimes quoted by sanguine persons, who are satisfied with the neglected condition of scientific training and research in this country, as really sufficient and adequate representatives of the German universities. As a matter of fact, the excellent English colleges in question do not present any thing at all comparable to the arrangements of a German university, and are, in respect of the amount of money which is expended upon them, the number of their teaching-staff, and the efficiency of their laboratories, inferior not merely to the smallest German university, but inferior to many of the technical schools of that country.

Passing from Germany, I would now ask your attention for a moment to an institution which is supported by the French government, and which — quite irrespective of the French university system, which is not, on the whole, superior to our own — constitutes one of the most effective arrangements, in any European state, for the production of new knowledge. The institution to which I allude is the Collége de France in Paris, — co-existing there with the Sorbonne, the École de médecine, the École normale, the Jardin des plantes, and other state-supported institutions, — in which opportunity is provided for those Frenchmen who have the requisite talent to pursue scientific discovery in the department of biology, and in other branches of science. I particularly mention the Collége de France, because it appears to me that the foundation of such a college in London would be one of the simplest and most direct steps that could be taken towards filling, in some degree, the void from which English science suffers. The Collége de France is divided into a literary and a scientific faculty. Each faculty consists of some twenty professors. Each professor in the scientific faculty is provided with a laboratory and assistants (as many as four assistants in some cases), and with a considerable allowance for the expenses of the instruments and materials required in research. The personal stipend of each professor is £400, which has been increased by an additional £100 a year in some cases from the government department charged with the promotion of higher studies. The professors in this institution, as in the German universities, when a vacancy occurs, have the right of nominating their future colleague, their recommendation being accepted by the government. The professors are not expected to give any elementary instruction, but are directed to carry on original investigations, in prosecuting which, they may associate with themselves pupils who are sufficiently advanced to join in such work; and it is further the duty of each professor to give a course of forty lectures in each year, upon the results of the researches in which he is engaged. There are at present, among the professors of the Collége de France, four of the most distinguished among contemporary students of biological science, — Professor Brown-Sequard, Professor Marey, Professor Balbiani, and Professor Ranvier. Every one who is acquainted with the progress of discovery in physiology, minute anatomy, and embryology, will admit that the opportunities afforded to these men have not been wasted. They have, as the result of the position in which they have been placed, produced abundant and most valuable work, and have, in addition, trained younger men to carry on the same line of activity. It was here, too, in the Collége de France, that the great genius of Claude Bernard found the necessary conditions for its development.

Let us now see how many and what kind of institutions there are in England devised so as to promote the making of new knowledge in biological science. Most persons are apt to be deceived in this matter by the fact that the terms 'university,' 'professorship,' and 'college' are used very freely in England in reference to institutions which have no pecuniary resources whatever, and which, instead of corresponding to the German arrangements which go by these names, are empty titles, neither backed by adequate subsidy of the state nor by endowment from private sources.

In England, with its 25,000,000 inhabitants, there are only four universities which possess endowments and professoriates; viz., Oxford, Cambridge, Durham, and the Victoria (Owens college). Besides these, which are variously and specially organized each in its own way, there are the London colleges (University and King's), the Normal school of science at South Kensington, and various provincial colleges, which are, to a small and varying extent, in possession of funds which could be or are used to promote scientific research. Amongst all these variously arranged institutions, there is an extraordinarily small amount of provision for biological research. In London there is one professorship only, that at the Normal school of science, which is maintained by a stipend paid by the state, and has a laboratory and salaried assistants similarly maintained, in connection with it. The only other posts in London which are provided with stipends intended to enable their holders to pursue researches in the domain of biological science, are the two chairs of physiology and of zoölogy at University college, which, through the munificence of a private individual,[1] have been endowed to the extent of £300 a year each. To these should be added, in our calculation, certain posts in connection with the British museum of natural history and the Royal gardens at Kew, maintained by the state; though it must be remembered that a large part of the expenditure in those institutions is necessarily taken up in the preservation of great national collections, and is not applicable to the subvention of investigators. We may, however, reckon about six posts, great and small, in the British museum, and four at Kew, as coming into the category which we have in view. In London, then, we may reckon approximately some fourteen or fifteen subsidized posts for biological research. In Oxford there fall under this category the professorship of anatomy and his assistant, that of physiology, that of zoölogy, that of botany. The Oxford professorships are well supported by endowment, averaging £700 or £800 a year; but they are inadequately provided with assistants, as compared with corresponding German positions. Whilst Oxford has thus five posts, Cambridge has at present the same number, though the stipends are of less average value. In regard to Durham, it does not appear that the biological professorships (which have their seat in the Newcastle college of science) are supported by stipends derived from endowment: they fall under another category, to which allusion will be made below, of purely teaching positions, supported by the fees paid for such teaching by pupils. The Victoria university (Owens college, Manchester) supports its professors of physiology, anatomy, zoölogy, botany, and pathology, by means partly of endowment, partly of pupils' fees. By the provision of adequate laboratories, and of salaries for assistants to each professor, and of student-fellowships, Owens college gives direct support to orginal investigation. We may reckon five major and eight minor posts as dedicated to biological research in this college. Altogether, then, we have fifteen positions in London and twenty-three in the provinces (taking assistantships and professorships and curatorships together), — a total of thirty-eight in all England, with its 25,000,000 inhabitants, as against the three hundred in Germany, with 45,000,000 inhabitants. In proportion to its population (leaving aside the consideration of its greater wealth), England has only about one-fourth of the provision for the advancement of biological research which exists in Germany.

[1] Mr. Jodrell.

It would not be fair to reckon in this comparison the various biological professorships in small colleges recently created, and paid to a small extent by stipends derived from endowments in the provincial towns of England: for the holders of these chairs are called upon to teach a variety of subjects; for instance, zoölogy, botany, and geology combined. And not only is the devotion of the energies of their teaching-staff to scientific discovery not contemplated in the arrangement of these institutions, but, as a matter of fact, the large demands made on the professors in the way of teaching must deprive them of the time necessary for any serious investigation. Such posts, in the fact that neither time, assistants, nor proper laboratories are provided to enable their holders to engage in scientific research, are schoolmasterships rather than professorships, as the word is used in German universities.

One result of the exceedingly small provision of positions in England, similar to those furnished by the German university system, and of the irregular, uncertain character of many of those which do exist, is, that there is an insufficient supply of young men willing to enter upon the career of zoölogist, botanist, physiologist, or pathologist, as a profession. The number of posts is too small to create a profession, i.e., an avenue of success; and consequently, whereas in Germany there is always a large body of new men ready to fill up the vacancies as they occur in the professorial organization, in England it very naturally does not appear to our university students as a reasonable thing to enter upon research as a profession, when the chances of employment are so few, and far between.

Before stating, as I propose to do, what appears to me a reasonable and proper method of removing, to some extent, the defect in our national life due to the want of provision for scientific research, I will endeavor to meet some of the objections which are usually raised to such views as those which I am advocating. The endowment of research by the state, or from public funds of any kind, is opposed on various grounds. One is, that such action on the part of the government is well enough in continental states, but is contrary to the spirit of English statecraft, which leaves scientific as well as other *enterprise* to the individual initiative of the people. This objection is based on error, both as to fact and theory. It is well enough to leave to individual effort the conduct of such enterprises as are remunerative to the parties who conduct them; but it is a mistake to speak of scientific research as an 'enterprise' at all. The mistake arises from the extraordinary pertinacity with which so-called 'invention' is confounded with the discovery of scientific truth. New knowledge in biological or other branches of science cannot be sold: it has no marketable value. Koch could not have sold the discovery of the bacterium of phthisis for as much as sixpence, had he wished to do so. Accordingly, we find that there is not, and never has been, any tendency among the citizens of this country to provide for themselves institutions for the manufacture of an article of so little pecuniary value to the individual who turns it out as is new knowledge. On the other hand, as a matter of fact, the providing of means for the manufacture of that article is not only not foreign to English statecraft, but is largely, though not largely enough, undertaken by the English state. The Royal observatories, the British museum, the Royal gardens at Kew, the Geological survey, the government grant of £4,000 a year to the Royal society, the £300 or £400 a year (not a large sum) expended through the medical officer of the privy council upon the experimental investigation of disease, are ample evidence that such providing of means for creating new knowledge forms part of the natural and recognized responsibilities of the British government. Such a responsibility clearly is recognized in this country, and does fall, according to the present arrangement of things, upon the central government. What we have to regret is, that those who temporarily hold the reins of government fail to perceive the lamentable inadequacy of the mode in which this responsibility is met.

A second objection which is made to the endowment of research by public funds, or by other means, such as voluntary contributions, is this: it is stated that men engaged in scientific research ought to *teach*, and thus gain their livelihood. It is argued, in fact, that there is no need whatever to provide stipends or laboratories for researchers, since they have only to stand up and teach in order to make income sufficient to keep them and their families, and to provide themselves with laboratories. This is a very plausible statement, because it is the fact that some investigators have also been excellent lecturers, and have been able to make an income by teaching, whilst carrying on a limited amount of scientific investigation. But neither by teaching in the form of popular lectures, nor by teaching university or professional students who desire, as a result, to pass some examination-test, is it possible, where there is a fair field and no favor, for a man to gain a reasonable income, and at the same time to leave himself time and energy to carry on original investigations in science.

In some universities, such as those of Scotland, the privilege of conferring degrees of pecuniary value to their possessors becomes a source of income to the professors of the university. They are, in fact, able to make considerable incomes, independently of endowment, by compelling the candidates for degrees to pay a fee to each professor in the faculty for the right of attending his lectures, and of presentation to the degree: consequently teaching here appears to be producing an income which may support a researcher. In reality, it is the acquisition of the university degree, and not necessarily the teaching, for which the pupil pays his fee. Where the teacher is unprotected by any compulsory regulations (such as that which requires attendance on his lectures, and fee-payment on the part of the pupils), it is *impossible* for him to obtain such an income, by teaching for one hour a day, as will enable him to devote the rest of the day to unremunerative study and investigation, for the following reason. Other teachers, equally satisfactory as teachers, will enter into competition with him, without having the same intention of teaching for one hour only, and of carrying on researches for the rest of the day. They will contemplate teaching for six hours a day, and they will accordingly offer to those who require to be taught, either six hours' teaching for the same fee which the researcher charges for one, or one hour for a sixth part of that fee: consequently the unprotected researcher will find his lecture-room deserted. Pupils will naturally go to the equally good teacher who gives more teaching for the same fee, or the same teaching for a less cost. And no one can say that this is not as it should be. The university pupil requires a certain course of instruction, which he ought to be able to buy at the cheapest rate. It does not seem to be doing justice to the pupil, to compel him to form one of a class consisting of some hundreds of hearers, where he can obtain but little personal supervision or attention from the teacher, whereas, if he had the free disposal of his fee, he might obtain six times the amount of attention from another teacher. This arrangement does not seem to be justifiable, even for the purpose of providing the university professor with an income, and leisure to pursue scientific research. The student's fee should pay for a given amount of teaching at the market value; and he has just cause of complaint, if, by compulsory enactments, he is taxed to provide the country with scientific investigation.

Teaching must, in all fairness, ultimately be paid for as teaching; and scientific research must be provided for out of other funds than those extracted from the pockets of needy students, who have a reasonable right to demand, in return for their fees, a full modicum of instruction and direction in study.

In the German universities, the professor receives a stipend which provides for him as an investigator. He also gives lectures, for which he charges a fee;

but no student is compelled to attend those lectures as a condition of obtaining his degree. Accordingly, independent teachers can and do compete with the professor in providing for the students' requirements in the matter of instruction. As a consequence, the fees charged for teaching are exceedingly small, and the student can feel assured that he is obtaining his money's worth for his money. He is not compelled to pay any fee to any teacher as a condition of his promotion to the university degree. In a German university, if the professor in a given subject is incompetent, or the class overcrowded, the student can take his fee to a private teacher, and get better teaching. All that is required of the candidate, as a condition of his promotion to the doctor's degree, is that he shall satisfy the examination-tests imposed by the faculty, and produce an original thesis.

Unless there be some such compelling influence as that obtaining in the Scotch universities, enabling the would-be researcher to gather to him pupils and fees without fear of competition, it seems impossible that he should gain an income by teaching, whilst reserving to himself time and energy for the pursuit of scientific inquiry. It is thus seen that the necessity of endowment, in some form or another, to make provision for scientific research, is a reality, in spite of the suggestion that teaching affords a means whereby the researcher may readily provide for himself. The simple fact is, that a teacher can only make a sufficient income by teaching, on the condition that he devotes his whole time and energy to that occupation.

Whilst I feel called upon to emphatically distinguish the two functions, — viz., that of *creating new knowledge*, and that of *distributing existing knowledge*, — and to maintain that it is only by arbitrary and undesirable arrangements not likely to be tolerated, or, at any rate, extended, at the present day, that the latter can be made to serve as the support of the former, I must be careful to point out that I agree most cordially with those who hold that it is an excellent thing for a man who is engaged in the one to give a certain amount of time to the other. It is a matter of experience, that the best teachers of a subject are, *ceteris paribus*, those who are actually engaged in the advancement of that subject, and who have shown such a thorough understanding of that subject as is necessary for making new knowledge in connection with it. It is also, in most cases, a good thing for the man engaged in research to have a certain small amount of change of occupation, and to be called upon to take such a survey of the subject in connection with which his researches are made, as is involved in the delivery of a course of lectures, and other details of teaching. Though it is not a thing to be contemplated, that the researcher shall sell his instruction at a price sufficiently high to enable him to live by teaching, yet it is a good thing to make teaching an additional and subsidiary part of his life's work. This end is effected in Germany by making it a duty of the professor (already supported by a stipend) to give some five or six lectures a week during the academical session, for which he is paid by the fees of his hearers. The fees are low, but are sufficient to be an inducement; and, inasmuch as the attendance of the students is not compulsory, the professor is stimulated to produce good and effective lectures at a reasonable charge, so as to attract pupils who would seek instruction from some one else, if the lectures were not good, or the fees too high. Indeed, in Germany this system works so much to the advantage of the students, that the private teachers of the universities at one time obtained the creation of a regulation forbidding the professors to reduce their fees below a certain minimum; since, with so low a fee as some professors were charging, it was impossible for a private teacher to compete. This state of things may be compared with much advantage with the condition of British universities. In these we hear, from one direction, complaints of the high fees charged, and of the ineffective teaching given by the professoriate; and in other universities, where no adequate fees are allowed to the professors as a stimulus to them to offer useful and efficient teaching, we find that the teaching has passed entirely out of their hands into those of college tutors and lecturers. The fact is, that a satisfactory relation between teaching and research is one which will not naturally and spontaneously arrange itself. It can hardly be said to exist in any British university or college, but the method has been thought out and carried into practice in Germany. It consists in giving a competent researcher a stipend, and a laboratory for his research work, and then requiring him to do a small amount of teaching, remunerated by fees proportionate to his ability and the pains which he may take in his teaching. If you pay him a fixed sum as a teacher, or artificially insure the attendance of his class, instead of letting this part of his income vary simply and directly with the attractiveness of his teaching, you will find as the result that (with rare exceptions) he will not give effective and useful teaching. He will naturally tend to do the minimum required of him in a perfunctory way. On the other hand, if you leave him without stipend as a researcher, dependent on the fees of pupils for an income, he will give all his time and energies to teaching: he will cease to do any research, and become, *pro tanto*, an inferior teacher.

A third objection which is sometimes made to the proposition that scientific research must be supported and paid for as such, is the following: it is believed by many persons that a man who occupies his best energies in scientific research can always, if he choose, make an income by writing popular books or newspaper articles in his spare hours; and, accordingly, it is gravely maintained that there is no need to provide stipends, and the means of carrying on their work, for researchers. To do so, according to this view, would be to encourage them in an exclusive reticence, and to remove from them the inducement to address the public on the subject of their researches, by which the public would lose valuable instruction.

This view has been seriously urged, or I should not here notice it. Any one who is acquainted with the sale of scientific books, and the profits which either author or publisher makes by them, knows that the suggestion which I have quoted is ludicrous. The writing of a good book is not a thing to be done in leisure moments; and such as have been the result of original research have cost their authors often years of labor, apart from the mere writing. Mr. Darwin's books, no doubt, have had a large sale; but that is due to the fact, apart from the exceptional genius of the man who wrote them, that they represent some thirty or more years of hard work, during which he was silent. There is not a sufficiently large public interested in the progress of science to enable a researcher to gain an income by writing books, however great his literary facility. A schoolbook or classbook may now and then add more or less to the income of a scientific investigator; but he who becomes the popular exponent of scientific ideas, except in a very moderate and limited degree, must abandon the work of creating new knowledge. The professional *littérateur* of science is as much removed by his occupation from all opportunity of serious investigation as is the professional teacher who has to consume all his time in teaching. Any other profession — such as the bar, medicine, or the church — is more likely to leave one of its followers time and means for scientific research than is that of either the popular writer or the successful teacher.

We have, then, seen that there is no escape from the necessity of providing stipends and laboratories for the purpose of creating new knowledge, as is done in continental states, if we are agreed that more of this new knowledge is needed, and is among the products which a civilized community is bound to turn out, both for its own benefit and for that of the community of states, which give to and take from one another in such matters.

There are some who would finally attack our contention by denying that new knowledge is a good thing, and by refusing to recognize any obligation, on the part of England, to contribute her share to that common stock of increasing knowledge by which she necessarily profits. Among such persons are those who would prohibit altogether the pursuit of experimental physiology in England, and yet would not and do not hesitate to avail themselves of the services of medical men whose power of rendering those services depends on the fact that they have learned the results obtained by the experiments of physiologists in other countries or in former times. In reference to this strange contempt and even hatred of science, which undoubtedly has an existence among some persons of consideration even at the present day, I shall have a few words to say before concluding this address. I have now to ask you to listen to what seems to me to be the demand which we should make, as members of a British association for the advancement of science, in respect of adequate provision for the creation of new knowledge in the field of biology in England.

Taking England alone, as distinct from Scotland and Ireland, we require, in order to be approximately on a level with Germany, forty new biological institutes, distributed among the five branches of physiology, zoölogy, anatomy, pathology, and botany, — forty, in addition to the fifteen which we may reckon (taking one place with another) as already existing. The average cost of the buildings required would be about £4,000 for each, giving a total initial expenditure of £160,000; the average cost of stipends for the director, assistants, and maintenance, we may calculate at £1,500 annually for each, or £60,000 for the forty, — equal to a capital sum of £2,000,000. These institutes should be distributed in groups of five — eight groups in all — throughout the country. One such group would be placed in London (which is at present almost totally destitute of such arrangements), one in Bristol, one in Birmingham, one in Nottingham, one in Leeds, one in Newcastle, one in Ipswich, one in Cardiff, one in Plymouth, — in fact, one in each of the great towns of the kingdom where there is at present, or where there might be with advantage, a centre of professional education and higher study. The first and the most liberally arranged of these biological institutes — embracing its five branches, each with its special laboratory and staff — should be in London. If we can have nothing else, surely we may demand, with some hope that our request will eventually obtain compliance, the formation in London of a College of scientific research similar to that of Paris (the Collége de France). It is one of the misfortunes and disgraces of London, that, alone amongst the capitals of Europe, with the exception of Constantinople, it is destitute of any institution corresponding to the universities and colleges of research which exist elsewhere.

Either in connection with a properly organized teaching university, or as an independent institution, it seems to me a primary need of the day that the government should establish in London laboratories for scientific research. Two hundred and fifty years ago Sir Thomas Gresham founded an institution for scientific research in the city of London. The property which he left for this purpose is now estimated to be worth three millions sterling. This property was deliberately appropriated to other uses, by the Corporation of the city of London and the Mercers' company, about a hundred years since, with the consent of both Houses of Parliament. By this outrageous act of spoliation these corporations, who were the trustees of Gresham, have incurred the curse which he quaintly inserted in his will in the hope of restraining them from attempts to divert his property from the uses to which he destined it. 'Gresham's curse' runs as follows: "And that I do require and charge the said Corporations and chief governors thereof, with circumspect Diligence and without long Delay, to procure and see to be done and obtained, as they will answer the same before Almighty God; (for if they or any of them should neglect the obtaining of such Licenses or Warrants, which I trust cannot be difficult, nor so chargeable, but that the overplus of my Rents and Profits of the Premisses hereinbefore to them disposed, will soon recompense the same; because to soe good Purpose in the Commonwealth, no Prince nor Council in any Age, will deny or defeat the same. And if conveniently by my Will or other Convenience, I might assure it, I would not leave it to be done after my death, then the same shall revert to my heirs, whereas I do mean the same to the Commonwealth, and then THE DEFAULT THEREOF SHALL BE TO THE REPROACH AND CONDEMNATION OF THE SAID CORPORATIONS AFORE GOD"). I confess that I find it difficult to see how the present representatives of the corporations who perverted Gresham's trust are to escape from justly deserving the curse pronounced against those corporations, unless they conscientiously take steps to restore Gresham's money to its proper uses. Let us hope that Gresham's curse may be realized in no more deadly form than that of an act of parliament repealing the former one which sanctioned the perversion of Gresham's money. Such a sequel to the report of the commission which has recently inquired into the proceedings of the corporation and companies of the city of London is not unlikely.

Whilst we should, I think, especially press upon public attention the need for an institute of scientific research in London, and indicate the source from which its funds may be fitly derived, we must also urge the foundation of other institutes in the provinces, upon the scale already sketched; because it is only by the existence of numerous posts, and of a series of such posts, — some of greater and some of less value, the latter more numerous than the former, — that any thing like a professional career for scientific workers can be constructed. It is especially necessary to constitute what I have termed 'assistantships,' that is, junior posts, in which younger men assist, and are trained by, more experienced men. Even in the few institutions which do already exist, additional provision of this kind is what is wanted more than any thing else, so that there may be a progressive career open to the young student, and a sufficient field of trained investigators from which to select in filling up the vacancies in more valuable positions.

I am well aware that it will be said that the scheme which I have proposed to you is gigantic and almost alarming in respect of the amount of money which it demands. One hundred and sixty thousand pounds a year for biology alone must seem, not to my hearers, but to those who regard biology as an amusing speculation, — that is to say, who know little or nothing about it, — an extravagant suggestion. Unfortunately, it is also true that such persons are very numerous, — in fact, constitute an overwhelming majority of the community; but they are becoming less numerous every day. The time will come, it seems possible, when there will be more than one member of the government who will understand and appreciate the value of scientific research. There are already a few members of the House of Commons who are fully alive to its significance and importance.

We may have to wait for the expenditure of such a sum as I have named, and possibly it may be derived ultimately from local rather than imperial sources, though I do not see why it should be; yet I think it is a good thing to realize *now* that this is what we ought to expend in order to be on a level with Germany. This apparently extravagant and unheard of appropriation of public money *is actually made every year in Germany.*

I think it is well to put the matter before you in this definite manner; because I have reason to believe that even those whom we might expect to be well informed in regard to such matters are not so, and, as a consequence, there is not that keen sense of the inferiority and inadequacy of English arrangements in these matters which one would gladly see actuating the conduct of English statesmen. For instance: only a few years ago, when speaking at Nottingham, the present prime-minister, who has taken an active part in re-arranging our universities, and has, it is well known, much interest in science and learning, stated that £27,000, the capital sum expended on the Nottingham college of science, was a very important contribution to the support of learning in this country, amounting, as he said he was able to state from the perusal of official documents, to as much as one-third of what was spent in Germany during the past year upon her numerous universities, which were so often held up to England as an example of a well-supported academical system. Now, I do not think that Mr. Gladstone can ever have had the opportunity of considering the actual facts with regard to German universities: for he was in this instance misled by the official return of expenditure on a single university, namely, that of Strasburg; the total annual expenditure on the twenty-one German universities being, in reality, about £800,000, by the side of which a capital sum of £27,000 looks very small indeed. I cannot but believe, that if the facts were known to public men, in reference to the expenditure incurred by foreign states in support of scientific inquiry, they would be willing to do something in this country of a sufficient and statesmanlike character. As it is, the concessions which have been made in this direction appear to me to be in some instances not based upon a really comprehensive knowledge of the situation. Thus, the tentative grant of £4,000 a year from the treasury to the Royal society of London appears to me not to be a well-devised experiment in the promotion of scientific research by means of grants of money; because it is on too small a scale to produce any definite effect, and because the money cannot be relied upon from year to year as a permanent source of support to any serious undertaking.

The Royal society most laboriously and conscientiously does its best to use this money to the satisfaction of the country, but the task thus assigned to it is one of almost insurmountable difficulty. In fact, no such miniature experiments are needed. The experiment has been made on a large scale in Germany, and satisfactory results have been obtained. The reasonable course to pursue is to benefit by the experience, as to details and methods of administration, obtained in the course of the last sixty years in Germany, and to apply that experience to our own case.

It is quite clear that 'the voluntary principle' can do little towards the adequate endowment of scientific research. Ancient endowments belonging to the country must be applied thereto, or else local or imperial taxes must be the source of the necessary support.

Seeing that the results of research are distinctly of imperial and not of local value, it would seem appropriate that a portion of the imperial revenue should be devoted to their achievement. In fact, as I have before mentioned, the principle of such an application of public money has long been admitted, and is in operation.

Whilst voluntary donations on the part of private persons can do little to constitute a fund which shall provide the requisite endowment for the scheme of biological institutes which I have sketched (not to mention those required for other branches of science), yet those who are interested in the progress of scientific investigation may, by individual effort, do something, however little, towards placing research in a more advantageous position in this country. Supposing it were possible, as I am sanguine enough to believe that it is, to collect in the course of a year or two, from private sources, a sum of £20,000 for the maintenance of a biological laboratory and staff: it would be necessary, in expending so limited a sum, to aim at the provision of something which would be likely to produce the largest and most obvious results in return for the outlay, and to benefit the largest number of scientific observers in this department.

I believe that it is the general opinion among biologists, that there could be no more generally useful institution thus set in operation than a biological laboratory upon the seacoast, which, besides its own permanent staff of officers, would throw open its resources to such naturalists as might from time to time be able to devote themselves to researches within its precincts. There is no such laboratory on the whole of the long line of British coast. At Naples there is Dr. Dohrn's celebrated and invaluable laboratory, which is frequented by naturalists from all parts of the world; at Trieste, the Austrian government supports such a laboratory; at Concarneau, Roscoff, and Villefranche, the French government has such institutions; at Beaufort, in North Carolina, the Johns Hopkins university has its marine laboratory; and at Newport Professor Alexander Agassiz has arranged a very perfect institution also for the study of marine life. In spite of the great interest which English naturalists have always taken in the exploration of the sea and marine organisms; in spite of the fact that the success, and even the existence, of our fisheries industries, to a large extent depend upon our gaining the knowledge which a well-organized laboratory of marine biology would help us to gain, — there is actually no such institution in existence.

This is not the occasion on which to explain precisely how, and to what extent, a laboratory of marine zoölogy might be of national importance. I hope to see that matter brought before the section during the course of our meeting. But I may point out now, that though it appears to me that the great need for biological institutes, to which I have drawn your attention, can *not* be met by private munificence, and must, in the end, be arranged for by the continued action of the government in carrying out a policy to which it has for many years been committed, and which has been approved by conservatives and liberals alike, yet such a special institution as a laboratory of marine biology, serving as a temporary workshop to any and all of our numerous students of the important problems connected with the life of marine plants and animals, might very well be undertaken from private funds. Should it be possible, on the occasion of this meeting of the British association in Southport, to obtain some promise of assistance towards the realization of this project, I think we shall be able to congratulate ourselves on having done something, though small, perhaps, in amount, towards making better provision for biological research, and therefore something towards the advancement of science.

In conclusion, let me say, that, in advocating to-day the claim of biological science to a far greater measure of support than it receives at present from the public funds, I have endeavored to press that claim chiefly on the ground of the obvious utility to the community of that kind of knowledge which is called biology. I have endeavored to meet the opposition of those who object to the interference of the state, wherever it may be possible to attain the end in view without such interference, but who profess themselves willing to see public money expended in promoting objects which are of real importance to the country, and which cannot be trusted to the voluntary enterprise arising from the operation of the laws of self-preservation, and the struggle for wealth. There are, however, it seems to me, further reasons for desiring a thorough and practical recognition by the state of the value of scientific research. There are not wanting persons of some cultivation, who have perceived and fully realized the value of that knowledge which is called science, and of its methods, and yet are anxious to restrain rather than to aid the growth of that knowledge. They find in science something inimical to their own interests, and accordingly either condemn it as dangerous and untrustworthy, or encourage themselves to treat it with contempt by asserting, that, 'after all, science counts for very little,' — a statement which is unhappily true in one sense, though totally untrue when it is intended to signify that the progress of science is not a matter which profoundly influences every factor in the well-being of the community. Amongst such people there is a positive hatred of science, which finds expression in their exclusion of it, even at this day, from the ordinary curriculum of public-school education, and in the baseless, though oft-repeated calumny, that science is hostile to art, and is responsible for all that is harsh, ugly, and repulsive in modern life. To such opponents of the advancement of science it is of little use to offer explanations and arguments. But we may, when we reflect on their instinctive hostility, and the misrepresentations of science and the scientific spirit which it leads them to disseminate, console ourselves by bringing to mind what science really is, and what truly is the nature of that calling in which a man who makes new knowledge is engaged.

They mock at the botanist as a pedant, and the zoölogist as a monomaniac; they execrate the physiologist as a monster of cruelty, and brand the geologist as a blasphemer; chemistry is held responsible for the abomination of aniline dyes and the pollution of rivers, and physics for the dirt and misery of great factory towns. By these unbelievers, science is declared responsible for individual eccentricities of character, as well as for the sins of the commercial utilizers of new knowledge. The pursuit of science is said to produce a dearth of imagination, incapability of enjoying the beauty either of nature or of art, scorn of literary culture, arrogance, irreverence, vanity, and the ambition of personal glorification.

Such are the charges, from time to time, made by those who dislike science; and for such reasons they would withhold, and persuade others to withhold, the fair measure of support for scientific research which this country owes to the community of civilized states. Not in reply to these misrepresentations, but by way of contrast, I would here state what science seems to be to those who are on the other side, and how, therefore, it seems to them wrong to delay in doing all that the wealth and power of the state can do to promote its progress.

Science is not a name applicable to any one branch of knowledge, but includes all knowledge which is of a certain order or scale of completeness. All knowledge which is deep enough to touch the causes of things is science: all inquiry into the causes of things is scientific inquiry. It is not only co-extensive with the area of human knowledge, but no branch of it can advance far, without reacting upon other branches: no department of science can be neglected, without sooner or later causing a check to other departments. No man can truly say this branch of science is useful, and shall be cultivated, whilst this is worthless, and shall be let alone: for all are necessary; and one grows by the aid of another, and in turn furnishes methods and results assisting in the progress of that from which it lately borrowed.

We desire the increase and the support and the acceptance of science, not only because it has a certain material value, and enables men to battle with the forces of nature, and to turn them to account so as to increase both the intensity and the extension of healthy human life: that is a good reason, and for some persons, it may be, the only reason. But there is something to be said beyond this.

The pursuit of scientific discovery, the making of new knowledge, gratifies an appetite, which, from whatever cause it may arise, is deeply seated in man's nature, and, indeed, is the most distinctive of his properties. Man owes this intense desire to know the nature of things, smothered though it often be by other cravings which he shares with the brutes, to an inherited race-perception, stronger than the reasoning faculty of the individual. When once aroused, and in a measure gratified, this desire becomes a guiding passion. The instinctive tendency to search out the causes of things, gradually strengthening as generation after generation of men have stumbled and struggled in ignorance, has at last become an active and widely extending force: it has given rise to a new faith.

To obey this instinct — that is, to aid in the production of new knowledge — is the keenest and the purest pleasure of which man is capable, greater than that derived from the exercise of his animal faculties in proportion as man's mind is something greater and further developed than the mind of brutes. It is in itself an unmixed good, the one thing which commends itself as still 'worth while' when all other employments and delights prove themselves stale and unprofitable.

Arrogant and foolish as those men have appeared, who, in times of persecution, and in the midst of a contemptuous society, have, with an ardor proportioned to the prevailing neglect, pursued some special line of scientific inquiry, it is nevertheless true that in itself, apart from special social conditions, science must develop, in a community which honors and desires it before all things, qualities and characteristics which are the highest, the most human of human attributes. These are, firstly, the fearless love and unflinching acceptance of truth; hopeful patience; that true humility which is content not to know what cannot be known, yet labors and waits; love of Nature, who is not less, but more worshipped by those who know her best; love of the human brotherhood, for whom and with whom the growth of science is desired and effected.

No one can trace the limits of science, nor the possibilities of happiness, both of mind and body, which it may bring in the future to mankind. Boundless though the prospect is, yet the minutest contribution to the onward growth has its absolute and unassailable value, — once made, it can never be lost: its effect is forever in the history of man.

Arts perish, and the noblest works which artists give to the world. Art, though the source of great and noble delights, cannot create nor perpetuate: it embodies only that which already exists in human experience, whilst the results of its highest flights are doomed to decay and sterility. A vain regret, a constant effort to emulate or to imitate the past, is the fitting and laudable characteristic of art at the present day. There is, indeed, no truth in the popular partition of human affairs between science and art as between two antagonistic or even comparable interests; but the contrast which they present in points such as those just mentioned is forcible. Science is essentially creative: new knowledge — the experience and understanding of things which were *previously non-existent for man's intelligence* — is its constant achievement. And these creations never perish: the new is built on, and incorporates, the old; there is no turning back to recover what has lapsed through age; the oldest discovery is even fresher than the new, yielding in ever-increasing number new results, in which it is itself reproduced and perpetuated, as the parent in the child.

This, then, is the faith which has taken shape in proportion as the innate desire of man for more knowledge has asserted itself: namely, that there is no greater good than the increase of science: that through it all other good will follow. Good as science is in itself, the desire and search for it is even better, raising men above vile things and worthless competitions, to a fuller life and keener enjoyments. Through it we believe that man will be saved from misery and degradation, not merely acquiring new material powers, but learning to use and to guide his life with understanding. Through science he will be freed from the fetters of superstition. Through faith in science he will acquire a new and enduring delight in the exercise of his capacities: he will gain a zest and interest in life such as the present phase of culture fails to supply.

In opposition to the view that the pursuit of science can obtain a strong hold upon human life, it may be argued, that on no reasonable ground can it appear a necessary or advantageous thing to the individual man to concern himself with the growth and progress of that which is merely likely to benefit the distant posterity of the human race. Our reply is, let those who contend for the reasonableness of human motives develop, if they can, any theory of human conduct in which reasonable self-interest shall be man's guide. We do not contend for any such theory. By reasoning we may explain and trace the development of human nature, but we cannot change it by any such process. It is demonstrably unreasonable for the individual man, guided by self-interest, to share the dangers and privations of his brother-man; and yet, in common with many lower animals, he has an inherited quality which makes it a pleasure to him to do so. It is unreasonable for the mother to protect her offspring, and yet it is the natural and inherited quality of mothers to derive pleasure from doing so. It is unreasonable for the half-starved poor to aid their wholly-starving brethren; and yet such compassion is natural and pleasurable to those who show it, and is the constant rule of life. Unreasonable though these things are, from the point of view of individual self-interest, yet they are done because to do them is pleasurable, to leave them undone a pain. The race has, as it were, in these respects, befooled the individual, and, in the course of evolution, has planted in him, in its own interests, an irrational capacity for taking pleasure in doing that which no reasoning in regard to self-interest could justify. As with these lower and more widely distributed instincts, shared by man with some lower social animals, so is it with this higher and more peculiar instinct, — the tendency to pursue new knowledge. Whether reasonable or not, it has, by the laws of heredity and selection, become part of us, and exists. Its operation is beneficial to the race. Its gratification is a source of keen pleasure to the individual, — an end in itself. We may safely count upon it as a factor in human nature. It is in our power to cultivate and develop it, or, on the other hand, to starve and distort it for a while, though to do so is to waste time in opposing the irresistible.

As day by day the old-fashioned stimulus to the higher life loses the dread control which it once exercised over the thoughts of men, the pursuit of wealth, and the indulgence in fruitless gratifications of sense, become to an increasing number the chief concerns of their mental life. Such occupations fail to satisfy the deep desires of humanity: they become wearisome and meaningless, so that we hear men questioning whether life be worth living. When the dreams and aspirations of the youthful world have lost their old significance, and their strong power to raise men's lives, it will be well for that community which has organized in time a following of and a reverence for an ideal good, which may serve to lift the national mind above the level of sensuality, and to insure a belief in the hopefulness and worth of life. The faith in science can fill this place. The progress of science is an ideal good, sufficient to exert this great influence.

It is for this reason, more than any other (as it seems to those who hold this faith), that the progress and diffusion of scientific research, its encouragement and reverential nurture, should be a chief business of the community, whether collectively or individually, at the present day.

NOTES AND NEWS.

Pursuant to the invitation already noted in Science, a number of gentlemen met in the library of the American museum of natural history in New-York City, on the 26th to 28th of September, and founded the American ornithologists' union. The membership consists of active, foreign, corresponding, and associate members. The active membership is limited to fifty residents of the United States and Canada; the foreign, to twenty-five non-residents of the United States and Canada; the corresponding, to one hundred residents of any country; the associate being composed of any number of residents of the United States and Canada. The officers of the union for the current year are, Mr. J. A. Allen, president; Dr. Elliott Coues and Mr. Robert Ridgway, vice-presidents; Dr. C. Hart Merriam, secretary and treasurer; Messrs. S. F. Baird, George N. Lawrence, H. W. Henshaw, and Montagu Chamberlain, councillors, — these nine officers constituting the council of the union. Dr. Coues presided over the convention, and continued in the chair in the absence of the president. Mr. Allen and Professor Baird, who were unable to be present, were added to the list of founders. After the discussion and adoption of a constitution, submitted by the committee of organization, and the election of officers, a large number of members were elected, raising the active and foreign membership nearly to the limit. The work of the union for the present year was laid out by the formation of committees, appointed by the chair, on the subjects of classification and nomenclature, of the distribution and migration of birds, of avian anatomy, of oölogy, and on the question of the eligibility or ineligibility of the European sparrow in America. The first-named committee, besides revising the current lists of North-American birds, is expected to consider the subject of zoölogical nomenclature at large; and its labors may result in the formation of a code of nomenclature applicable to other departments of zoölogy, as well as to ornithology. It consists of Messrs. Ridgway, Allen, Brewster, Henshaw, and Coues.

— Mr. Charles F. Parker, the curator in charge of the Academy of natural sciences of Philadelphia, died Sept. 7, after an illness of several months. Mr. Parker became a member of the academy in 1865, and was elected a curator in 1873. Shortly afterward he was appointed by the council curator in charge,— a position which he filled with singular efficiency until last March, when he was compelled to avail himself of leave of absence, granted by the council in the hope that he would soon be able to return. Mr. Parker had paid special attention to the botany of New Jersey; and, both in the completeness of his herbarium and the accuracy of his knowledge of it, he had few, if any, equals. Even before his connection with the academy, he was well known to the leading botanists of America, and his collection was frequently referred to by specialists for illustrative material. The many students who have visited the academy during his term of office will remember the alacrity with which he rendered them assistance in their investigations. Although he may be succeeded by one having a more general knowledge of natural history in its several departments, or a more profound knowledge of a specialty, the academy will probably not be able to secure the services of any one person able and willing to perform the same work so economically and efficiently.

— We copy from the daily press the following telegram from Lieut. Ray, commanding the Point-Barrow expedition, concerning whose safety there were reasonable grounds for anxiety:—

"San Francisco, Oct. 7, 1883. — I report my safe arrival here to-day with party. Also brought down Lieut. Schwatka and party from St. Michaels. All work accomplished as ordered by chief signal-officer. Pendulum observation not made. Leo reached Ooglaamie Aug. 22; was driven away by ice the same night; returned on the 24th; again driven away and damaged on the 25th; returned on the 27th, when party and stores were embarked; sailed on the 29th, vessel leaking badly; put into Unalaska, where she was beached and repaired."

— A large and exceptionally fine collection of fossil plants from the Fort-Union group (Laramie) is now on its way to Washington, collected in the valley of the Yellowstone River, within thirty miles of Glendive, Montana, by Mr. Lester F. Ward, assisted by Mr. Richard Foster. Mention has already been made (Science, i. 559) of a small but interesting collection from this locality, which was partially elaborated last spring. The same stations were revisited and thoroughly worked. The expedition was very successful, and the collection is one of the largest and best ever made in the country. Fifty-seven boxes of fossils, aggregating nearly four tons in gross weight, were obtained. The material was carefully assorted, and scarcely any but cabinet specimens were taken. In the very large number of genera and species represented, there can scarcely fail to be some new to science. The localities examined embrace several distinct horizons within the group, each possessing a special facies. Nearly all the old forms described by Dr. Newberry appear in abundance,— Populus, Platanus, Viburnum, Rhamnites, Tilia, etc.,— but varied by additional species; while such new genera as Trapa, Rhamnus, Ilex, Eleodendron, Asarum, Ficus, etc., are present, often in great profusion, and beautifully preserved. Special pains were taken to secure as large and complete a representation as possible of those forms whose affinities are less obvious or wholly unknown. Mr. Ward intends to commence work on this collection as soon as it arrives.

— The 13th of August, 1883, was the hundredth anniversary of the successful attempt of the brothers Montgolfier to cause their hot-air balloon to rise. On that day a monument commemorative of the

event was unveiled at Annonay, where the Montgolfiers lived and worked. Joseph, the older, is represented as holding the balloon, while his younger brother, Étienne, fills it with heated air by means of a lighted torch. For the three days the streets of Annonay were filled with the crowds gathered to honor the memory of the great inventors. In the addresses stress was laid upon the aids which the use of the balloon may be to the sciences, especially meteorology, and in military operations. Joseph Montgolfier was born at Vidalon-les-Annonay, Aug. 26, 1740, and Etienne at the same place, the 7th of January, 1745. The younger brother died Aug. 2, 1799, at Serrière; and Joseph, after a stroke of paralysis in 1809, died at Balaruc-les-Bains on the 26th of June, 1810.

— A notable event of the present season's field-work has been the descent of the Missouri River in a 'Mackinaw' (a sort of flat boat) from Fort Benton to Bismarck by a party of geologists, consisting of Dr. C. A. White, Mr. J. B. Marcou, and Mr. Lester F. Ward, with one assistant, for the express purpose of geological and paleontological study.

The distance, according to steamboat schedule, is 1,059 miles; and thirty days (Aug. 22 to Sept. 20) were consumed in the journey. A large part of the territory passed through is occupied by Indian reservations; and there is no white population between Benton and Poplar Creek Agency, the first post-office, — a distance of 567 miles. The river is very low at this season of the year; and the current was correspondingly sluggish, though still quite rapid enough in some places. Progress was farther impeded by shoals, bars, and head winds; and considerable time was, of course, occupied in climbing and examining the adjacent bluffs and mountains.

The geology of this region, as all know, is very interesting; and the trip is believed to have thrown much light upon some of its leading problems. The results of the expedition will, of course, be officially made known in due time by the several parties participating, who have brought with them ample data, both in the form of notes and specimens.

— Mr. G. Brown Goode arrived in Washington on the 2d inst. from London.

— Representatives of nearly all the branches of the western surveys have returned to Washington. Dr. C. A. White reports having explored a great number of miles of the upper Missouri in a row-boat, being engaged in extending and confirming his previous observations of the formations.

— The winter session of the Philosophical society of Washington opens on the 13th inst. A considerable number of communications on widely different topics are in readiness. Biological papers are not numerous. The Biological society will probably begin its session on the 19th inst. It is possible that negotiations for the formation of a Washington academy of sciences will be opened for a second time this winter, but with what success it is impossible at present to say. It seems to be generally considered that an academy would be desirable, but there is little agreement relative to the proper basis of union between the existing societies.

— Prof. K. A. Zittel of Munich is visiting this country, and will probably be in Washington early in this month.

— At the first autumn meeting of the Boston society of natural history, Oct. 3, Mr. F. W. Putnam gave an account of the great serpent-mound in Adams county, O., and of some other ancient works in Wisconsin and Ohio examined during the past summer.

— The Appalachian mountain-club commenced its Boston meetings on the 10th, when papers were read on the Route Salvan, by Selah Howell; on a trip over Osceola, the Twin Mountain range, and Garfield, by W. L. Hooper; and on an exploration of the Traveller Mountain, and the head waters of Mattagamon River, by G. H. Witherle.

RECENT BOOKS AND PAMPHLETS.

Aymard, J. La poudre à canon; le télégraphe; les montagnes et les volcans; les tremblements de terre, les pétrifications. Paris, *Lefort*, 1883. 107 p. 12°.

Barrois, T. Catalogue des crustacés podophtalmaires et des échinodermes recueillis à Concarneau durant les mois d'août-septembre, 1880. Lille, *impr. Danel*, 1883. 68 p., pl., map. 8°.

Berquin. Les merveilles du firmament, ou le système de la nature dévoilé à la jeunesse. Limoges, *Ardant*, 1883. 119 p. 8°.

Bonnet, E. Petite flora parisienne, contenant la description des familles, genres, espèces et variétés de toutes les plantes spontanées ou cultivées en grand dans la région parisienne, avec des clefs dichotomique conduisant rapidement aux noms des plantes; augmentée d'un vocabulaire. Paris, *Savy*, 1883. 12+528 p. 18°.

Brass, A. Biologische studien. Theil i.: Die organisation der thierischen zelle. 8°.

Broca, P. Memoires d'anthropologie. Paris, *Reinwald*, 1883. 800 p. 8°.

Chatenet, E. du. Pompéi et Herculanum, découverte et description de ces deux villes romaines. Limoges, *Ardant*, 1883. 120 p. 12°.

Cole, E. M. Geological rambles in Yorkshire: a popular handbook of magnesian limestone, new red sandstone, etc. London, *Simpkin*, 1883. 112 p. 8°.

Costatin, J. Étude comparée des tiges aériennes et souterraines des dicotylédones. Paris, *Masson*, 1883. 177 p., 8 pl. 8°.

D'Anvers, U. Flowerless plants. London, *Philip*, 1883. (Sc. ladders.) 84 p. 12°.

De Long, Emma. The voyage of the Jeannette; the ship and ice journals of George W. De Long. Edited by his wife. 2 vols. Boston, *Houghton, Mifflin, & Co.*, 1883. 22+911 p., 2 portr., 5 maps, 14 pl., illustr. 8°.

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—— Les animaux dans les bois. Limoges, *Ardant*, 1883. 192 p. 8°.

—— Les oiseaux et les insectes. Limoges, *Ardant*, 1883. 191 p. 8°.

—— Les végétaux dans les bois. Limoges, *Ardant*, 1883. 192 p. 8°.

Duclau, S. La science populaire; la chaleur et ses effets. Limoges, *Ardant*, 1883. 120 p. 12°.

Exposition internationale d'électricité, Paris, 1881. Jury reports. 2 vols. Paris, *Masson*, 1883. 484; 414 p. 8°.

Frenzel, J. Ueber bau und thätigkeit des verdauungskanals der larve der Tenebrio moliter mit berücksichtung anderer arthropoden. Inaug. diss. Göttingen, *Vandenhoeck & Ruprecht*, 1882. 50 p. 8°.

Govin, M., and **Moireau**, M. Notions de cosmographie. Paris, *Bertaux*, 1883. 36 p. 18°.

Gresley, W. S. A glossary of terms used in coal-mining. London, *Spon*, 1883. 306 p., illustr. 8°.

Heaford, A. S. Strains on braced iron arches and arched iron bridges. London, *Spon*, 1883. illustr. 8°.

Illinois — Geological survey. Vol. 7. Geology and paleontology, by A. H. Worthen. Paleontology, by A. H. Worthen, O. St. John, and S. A. Miller; with an addenda (*sic*) by C. Wachsmuth and W. H. Barris. (Springfield), *State*, 1883. (4)+373 p., 31 pl. l. 8°.

Kutscher, E. Die verwendung der gertsäure im stoffwechsel der pflanze. Inaug. diss. Göttingen, *Vandenhoeck & Ruprecht*, 1883. 36 p., 2 pl. 8°.

Lackemann, W. Euler's interpolirte producte. Inaug. diss. Göttingen, *Vandenhoeck & Ruprecht*, 1882. 43 p. 8°.

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Mouillefert, P. Vignes phylloxerées; faits établissant l'efficacité et la haute valeur du sulfocarbonate de potassium pour combattre le phylloxera, etc. Paris, *Narbonne*, 1883. 58 p. 4°.

Munro, J. Electricity and its uses. London, *Tract society*, 1883. illustr. 8°.

Pichler, M. von. L'indicateur du travail et du fonctionnement des machines à piston, à vapeur, à eau, à gaz, etc., et son diagramme. Traduit par R. Seguela. Paris, *Baudry*, 1883. 5+98 p., 46 fig. 8°.

SCIENCE.

FRIDAY, OCTOBER 19, 1883.

PRECISION OF OBSERVATION AS A BRANCH OF INSTRUCTION.

We sometimes find the philosopher envying the physicist because the results sought by the latter can be expressed *exactly*. In so doing, he doubtless overlooks the fact that all quantitative work has to be regarded as giving merely an approximation to the truth. Numerous and refined as are the precautions adopted, the careful experimenter must admit that his measurements contain errors whose sources are more or less hidden. Success will lie, not in ignoring this, but in recognizing it, and studiously avoiding any unwarranted claim to accuracy. His investigation may establish some law beyond a reasonable doubt. This law may be expressible in exact terms; but, so far as the direct quantitative results are concerned, he must give up, once for all, the popular notion of exactness. He must admit that the work merely shows it to be reasonable to assume the truth to lie somewhere between two limits, respectively greater and less than the one magnitude which he names. Desiring that these limits shall fall as near together as practicable, he will study the observations for internal evidence of the precision attained; but any appearance of accuracy greater than might reasonably be expected will often cause him more uneasiness than would a greater apparent error. Until the extent of the error is recognized, and found to be in harmony with experience derived from other similar observations, a cautious observer will not be confident of the result reached.

As the scientific professions are currently taught, it is possible to get a fair training (as a chemist, engineer, or electrician, for example) without properly appreciating the practical limitations to precision. He may instinctively acquire correct notions of the performances of the instruments he most frequently uses; but let a new operation, with a different instrument, be required, and he will too often develop the wildest notions as to the great accuracy attainable by the use of sufficient care. What is needed in our professional courses is systematic instruction in the general science of planning, conducting, and discussing observations, accompanied with adequate practice. This should be given as early as the student is fitted to profit by it, in order that the subsequent practical training in special branches may have a firm foundation.

The field for such instruction is ample. A good routine observer is one who, being informed of the accuracy desired at each step, is able to take just care enough to attain it, without wasting time and energy in uselessly perfecting certain parts of the work. Our professional observer must add to this the good judgment which is able to discover the relative accuracy required in different parts of a complex observation, and to decide how accurate to aim to make a single performance of the whole. In general, he will seek to avoid errors which usually occur in a single direction; but he will not always take the greatest care to avoid errors which are as liable to be negative as positive. Life is short. Time, to most, is money; and the ability to repeat an observation will often depend upon the ability to do it quickly. Moreover, in many cases, mere lapse of time allows additional errors to enter. Having avoided the larger errors, he will therefore seek to eliminate the effect of the smaller by repeatedly performing the work. Recognizing, then, the importance of reasonable speed, he will allow rough measures of certain quantities, provided the final error of the complex operation is not thereby appreciably affected. All this calls for a clear understanding of the causes of error, and an ability to reason out their effect upon the result. The knowledge of the differential calculus required is indeed elementary; but it must be a *tool* which can be applied as readily, for instance, as the knowledge of the properties of logarithms. All the principles are covered by the customary courses in physics and mathematics; but additional special practice in their employment is very desirable.

In the planning of observations, the theory of maxima and minima gives important aid; but this theory has so many other applications, that we can hardly ask of the regular course in differential calculus such attention to this one point as would insure the required facility. In the absence of such a course of instruction as is recommended in this paper, the matter is left to slow acquisition through practical experience. Knowledge is often thus bought at a high cost.

A general understanding of instruments of precision, so necessary to successful planning of observations, is also within the field of instruction proposed. Instrumental errors should be treated systematically: their preliminary adjustment to zero, their elimination from the mean of pairs of observations properly taken to that end, their determination in such manner that corrections may be duly applied, and the cost in time of variously managing them, should come to be understood through suitable practice. Here, particularly, each professional course is liable to inculcate its own narrow view.

An examination of the proceedings of the leading learned societies will convince one of the importance of good method in the discussion of results. It will also develop the fact that there exist numerous valuable, analytical, and graphical processes, which at present are not likely to be brought to the attention of the professional student.

The theory of probabilities as applied to observation would naturally be treated in the course proposed. If it were previously given to the student as a branch of pure mathematics, the attention could here be riveted upon its use, which calls for the exercise of much practical good judgment. It furnishes an important means of studying the precision attained, but just here is a great abuse. Its results, demonstrated for a very large number, are applied to very limited series of measurements. Again: its assumption of equal probability for equal positive and negative errors is allowed, in face of the fact that a preponderance of error in one direction is unavoidable. The rising generation of experimenters in every field of applied science should therefore be taught the many limitations which surround its application, and they should learn to avoid that indiscriminate use of its principles which has led to so many unfounded claims to accuracy.

We have outlined a subject the successful teaching of which requires qualifications not to be found in every scientific professor, and the successful study of which requires a concentration of the attention not likely to be given to it as a subordinate part of some other course. Already the appearance of treatises on probabilities, errors of observation, and least squares, has enabled writers on astronomy, geodesy, physics, and engineering, to devote their attention to special applications, and has saved the waste of space which would otherwise be given to the general theory. Similarly, we should avoid that distraction of the student's attention from the main subject of a professional course which results from the necessity of frequently pausing to give additional information about the subject of this article.

Although the first object of establishing a course of instruction in any branch of applied science is to put the students into possession of the best methods already reached by workers in that field, the end attained is often something more. The instructor's attention is speedily called to conspicuous omissions, and his energies are consequently bent upon supplying the defect by demonstrating and testing some theorem or method which meets the want. Thus the schools come to the aid of the professions. Are they yet doing their whole duty in regard to the science and art of observation?

A SYSTEM OF LOCAL WARNINGS AGAINST TORNADOES.

I have lately examined with some care the excellent compilation by Sergeant Finley of the signal-service, 'Characteristics of six hundred tornadoes,' with reference to the question of devising a simple apparatus for saving human life.

Saving property seems to be out of the question, as no structure can withstand the force of the tornado-wind. Life may be saved by recourse to underground shelters, cellars, etc., such as actually have been built in many places for this end.

Two facts may be quoted from the work named, — 1°. Three hundred and forty-seven out of three hundred and ninety-three tornadoes (that is eighty-eight per cent) originated between the west and the south-south-west points; 2°. The average velocity of progression was about one mile in two minutes.

From what we already know of the atmospheric conditions necessary to the production of tornadoes, it seems probable that in the future it may be practicable for the general weather service in Washington to send out warnings a day in advance to large regions of country within which tornadoes are likely to occur. These warnings would necessarily be of a very general nature. They would simply state that the conditions were such on two sides of a large region (like the state of Wisconsin, for example) as to make it probable that tornadoes would occur somewhere inside that region within twenty-four hours. The local weather services of states like Ohio and Iowa could, perhaps, make these predictions a little more specific; but there is no prospect whatever that warnings of any particular tornado can be given in the immediate future. It can be said, that, within a district five hundred miles square, tornadoes are likely to occur within twenty-four hours. and such a warning would be of value; but it does not seem to be probable that it can be said that a particular thirty miles square of this region is in particular danger. Under these circumstances, it is of interest and importance to inquire whether some efficient method of local warnings cannot be devised. If five minutes' warning could have been given at any of the late tornadoes, many lives might have been saved. If each household could be warned by the continuous ringing of a bell, for example, that a wind of destructive force (say, seventy miles per hour and upwards) was approaching, and that five minutes were available in which to seek shelter, this would be well worth doing.

A wind of seventy miles an hour is sufficient to blow down chimneys and to unroof houses, unless they are well built. Ordinary trees will not stand under it. The pressure on a square foot is in the neighborhood of fifty pounds. There might be occasions where seventy miles would be the maximum wind-velocity; and the person who had taken refuge in the cellar might be inclined, after the gust had blown over, to find fault with the indicator which had predicted a tornado, when only a violent gale occurred. But such storms do not occur as often as once a year: and it would seem that one could afford to be frightened as frequently as this for the sake of immunity from an occasional tornado, which might be following in the track of such a violent gale.

I have found that it is practicable to erect, at a moderate expense (less than five hundred dollars), an apparatus which would give from three to five minutes' warning to all the inhabitants of a small town, by the firing of a cannon, for instance; and in addition, and without any increased expense, this apparatus could ring a bell in every house. The additional expense to each house would be less than ten dollars, the cost of maintenance would be less than a hundred dollars a year, and the work could be done by any intelligent person. The system, for a small town, would be something like the following: suppose a circle described about the town with a radius of from two to two and one-half miles. The only serious danger from tornadoes is to be feared from the part of this circle between the west point and the south-south-west point. Along the circumference of this circle, between the south-south-west and west points, run a line of single telegraph-wire on twenty posts to the mile, and from the west point bring the wire into the town, letting it end at the telegraph-office. It is grounded at each end of the line, and at the telegraph-office it is connected with a battery, which sends a constant current over the line. Within the town, connection is made in various houses with magnets. Each magnet holds a detent, which prevents a bell from being rung by the action of a cheap clock-work governed by a coiled spring. If the circuit is broken anywhere in the line, each bell begins to ring, and continues to sound till its spring is run down; for four or five minutes, for example. A cannon could be fired by a simple device, which would warn persons in the fields, etc., to seek shelter. In a large town the circuit might end in one of the engine-houses of the fire-department, and ring a bell there. This would be the signal for the man on watch to repeat the warnings simultaneously through as many local circuits as desirable.

It remains to indicate the way in which the circuit is to be broken by the wind. The circle of telegraph-poles from the south-south-west to the west points would contain about fifty poles. On every one of these the wire would run first to an insulator, then to an iron horizontal axis screwed into the side of the post. On this axis a piece of board one foot square can revolve freely. An iron rod projects below this board, and from the lower end of it a small wire goes to a pin in the telegraph-pole. This pin is connected by wire to a second insulator. From this the line goes to the next pole, and so on. The circuit ordinarily passes to the first insulator, thence to the iron rod, thence down the iron rod to the thin wire, through the pin and to the second insulator, and so to the next telegraph-pole. The thin wire is a necessary part of the circuit. It is so made that it will break when the pressure of the wind on the square board is fifty pounds. The apparatus for each post is tested practically before it is set up. This can be done at any time in a simple manner. Whenever any single one of these boards is subjected to the pressure of fifty pounds, its wire will be ruptured, and the circuit will be broken, thus sending the necessary warning along the whole line.

I have made one such indicator, which is connected with a small bell in this observatory. The wire is arranged so that it breaks at a wind-velocity of about ten miles per hour, and it works in a perfectly successful manner. The extension of the system for the protection of a small town is a simple matter. For a large city a more expensive system would have to be provided, as the wires between poles should be carried underground to protect them from the chance of disturbance.

I need not enlarge on the details of the scheme, since they can be worked out by any one who is at all familiar with electrical constructions. I believe that I have considered all the practical difficulties, and that there are none of any importance. It is a very simple matter to provide for the inspection of the line, bells, etc., so as not to interfere with the working of the system, and so that false alarms will not be given.

The point I wish to emphasize is, that a practical and cheap system of local warnings can be had, and that it ought to be considered by those who live in districts subject to tornadoes. The particular manner in which the above-described device is to be employed is a question to be settled by the particular circumstances of each case. I have only described the simplest and cheapest form, but this has been proved by trial to be efficient.

I may just mention, that, by employing a spring balance to hold the board in position, it is possible to provide an indicator which will break the circuit at any desired velocity of wind.

To any one who has seen the effects of a tornado, or even to one who has simply read that in this year alone several hundreds of lives have been lost from their violence, it will appear that the question of erecting systems for local warnings ought to be seriously considered by persons living in exposed regions.

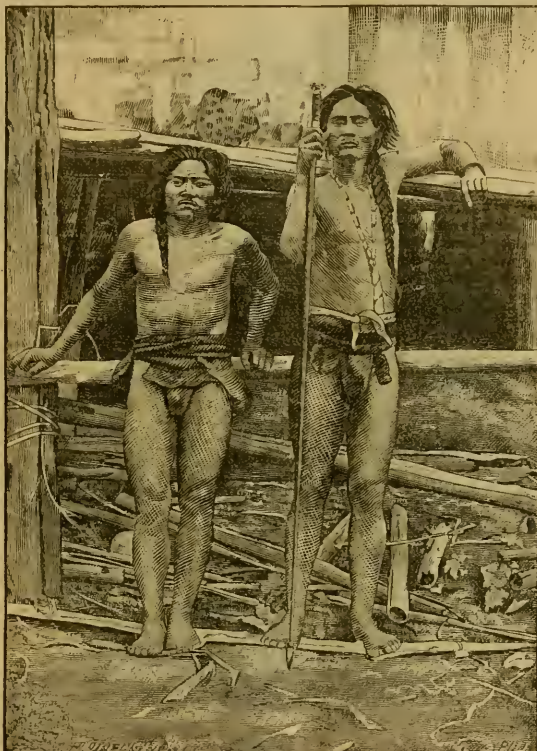
Edward S. Holden.

THE WILD TRIBES OF LUZON.

When the Malays took possession of the Philippines, they either found there, or were soon joined by, Japanese, Chinese, Siamese, Javanese, and Dyaks from Borneo and Celebes, all waging war against the Papuans, who had gone there from the south-east, if they were not aborigines. Under these circumstances, we should expect to find the present natives a very mixed race, who have received different names, according to the predominating characters in each locality. There is no unanimity of opinion among those who have studied the people in their own homes, and I think it impossible wholly to unravel the tangled skein of races. The following is what, from my observation and reading, I think a fair approximation to the truth.

The name of *Igorrote* has been applied to almost every wild tribe except the Negritos. I agree with Dr. Semper that it should be restricted to those of northern Luzon, who are hybrids of Japanese and Chinese with the Indians, differing somewhat in features and customs, according to the principal admixture.

In the Igorrote the stature is small, with well-developed form, indicating great strength with little symmetry; color very dark; eyes oblique; hair long, and, in the women, combed in Chinese fashion; nose flat, lips thick, mouth large, and cheeks wide. Houses mere huts, on the ground or raised on posts, shaped like a beehive, with furniture of the rudest description, — arms, hatchets, lances, daggers, bows and arrows, frequently poisoned, of bamboo, and shields. Their presence would be accounted for as the descendants of the army of the Chinese pirate, Li Mahon, whose fleet was destroyed after his attack on Manila in 1574. The fugitives escaped to the mountains; and for more than three centuries these wild hybrids between Chinese and Indian have defied the power of Spain. They have many dialects, but the Igorrote proper is spoken by over ten habit northern Ilocos. They are of finer shape, lighter color, with less oblique eyes, and more aquiline nose. In their habits, music, and love for porcelain vases, they resemble the Japanese, and have probably descended from the union of crews of junks, driven to Luzon by the northern monsoon, and the neighboring tribes.



IGORROTES OF LUZON.

thousand people. They are not wholly savage, except in the remote mountainous districts. Their customs are simple and patriarchal. It is only of late years that they have consented to bury their dead, instead of exposing them to decay in the air.

The name of *Tinguians* has been given to the hybrids of Japanese and Indians who in-

They number over nine thousand in twenty villages. Their dress and arms are much like those of the Igorrotes, but they have borrowed from their enemies the Gaddans the custom of preserving as trophies the heads of those killed in battle. They are said to mummify their dead by heat.

The *Gaddans* and *Ifuagos*, numbering about ten thousand, resemble in their appearance and customs the Dyaks of Borneo. Many dwell in the provinces of the Camarines, where they have preserved their independence. They have traditions of great antiquity, and speak the Vicol dialect as well as their own. They were evidently here before the Mahometan Malays, by whom they have been driven to the mountains. They are hostile to all foreigners. Their mode of life is patriarchal, the head of a family recognizing no superior authority. From the resemblance of the skulls of some of these wild tribes to those of the people of Sunda, Borneo, and Celebes, and the occurrence of similar ones in the long disused caverns, it seems undeniable that there is among them a considerable Dyak mixture, and that from a very remote period.

The above-mentioned races are what the Spanish writers call the *infidels*, and may or may not be Igorrotes. SAMUEL KNEELAND.

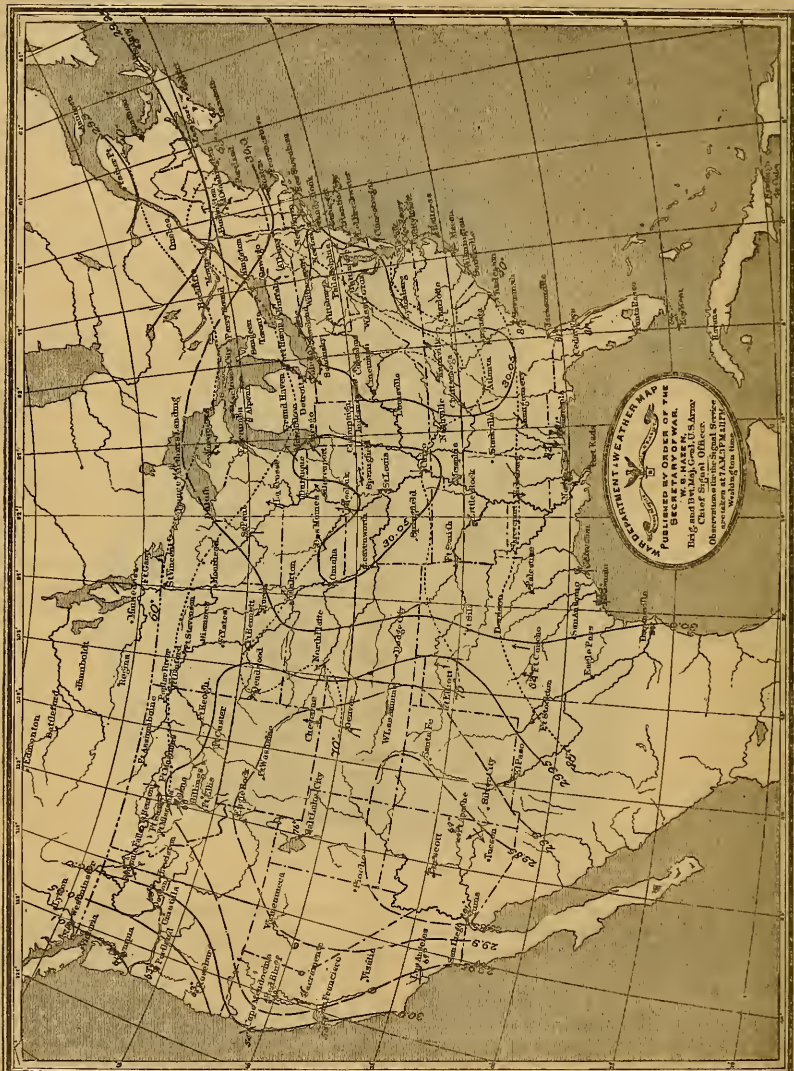
GADDAN OF LUZON.

THE WEATHER IN AUGUST, 1883.

THE monthly review of the U. S. signal-service shows that in August there were two features of special note. These are, 1°, the low temperatures which prevailed over nearly the whole country; 2°, the small rainfall, which was below the average in nearly every district. Other important features were a few destructive storms, and the opening of the hurricane season, as will be referred to below.

The pressure has been above the normal, except on the Atlantic coast; the greatest excess, 0.08 inch, occurring in the upper Mississippi and Missouri valleys, where, also, the lowest temperature departures were recorded. Six barometric depressions were charted in their progress, and a seventh begun, as the month closed. Of these, one only visited the southern states: this developed in Mississippi, passed off the Virginia coast, and across the Atlantic to the Irish coast, being a severe storm all along its passage. Of the other depressions, one developed in the Rocky Mountains, and was traced to the British coast, and another entered the country in the extreme south-west, moved south-easterly to the North Carolina coast, and in the ocean probably united with a tropical hurricane which was then moving up the Atlantic. None of the storms were traced from the Pacific coast over the Rocky Mountains. The storms left no disastrous effects in the United States; but there were violent gales on the upper lakes on the 22d, and remarkably heavy rains on the North Carolina coast on the 16th. The storms on the Atlantic were especially prominent, and the general character of the weather on the ocean during the whole month was stormy. Five depressions were traced nearly across the Atlantic, two of which were genuine hurricanes. The first moved north-westward at a considerable distance from the Atlantic coast, between the 19th and 24th, when it curved to the north-eastward near the Bermudas. Reaching the Banks on the 26th, it caused great damage to the fishing-fleet, the reports showing a loss of eighty lives and one hundred dories, while many fishing-vessels were swamped or disabled. Vessels on the Atlantic report severe gales during its further passage, but its severity decreased as it approached the Irish coast on the 29th. The lowest pressure

GADDAN WOMAN.



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, AUGUST, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF THE CHIEF SIGNAL-OFFICER.

noted was 28.9 inches. The second hurricane came from the West Indies about the 24th, and reached the Banks on the 29th, only three days after the passage of the former hurricane, repeating the disasters to the fishing-vessels. Its violence was great as it continued across the Atlantic, and approached the British coasts early in September. As this storm passed up the Atlantic, very high tides were experienced on the coast, much damage being thereby inflicted on the New Jersey shore on the 29th. Very few icebergs were reported during the month.

The average temperatures were above the normal only in Florida, the Rio Grande valley, and in the middle and southern portions of the Rocky Mountain region, the departures being within a degree, except at Salt Lake City (2°). In other districts the departures ranged from 0°.1, in the eastern Gulf states, to 4°.4, in the upper Mississippi valley. Yuma, Arizona, reports a mean temperature of 91°, and a maximum of 111°. Frosts were reported from the northern states, especially at the end of the month.

Average precipitation for August, 1883.

Districts.	Average for August. Signal-service observations.		Comparison of August, 1883, with the average for several years.
	For several years.	For 1883.	
	Inches.	Inches.	Inches.
New England	4.33	1.53	2.80 deficiency.
Middle Atlantic states .	4.95	3.20	1.75 deficiency.
South Atlantic states . .	6.43	7.51	0.72 deficiency.
Florida peninsula . . .	7.67	5.69	1.98 deficiency.
Eastern gulf	6.33	4.39	1.94 deficiency.
Western gulf	4.27	1.62	2.65 deficiency.
Tennessee	3.92	3.51	0.41 deficiency.
Ohio valley	3.70	1.94	1.76 deficiency.
Lower lakes	2.91	2.30	0.61 deficiency.
Upper lakes	3.12	1.25	1.87 deficiency.
Extreme north-west . .	2.50	2.70	0.20 excess.
Upper Mississippi valley,	3.40	1.87	1.53 deficiency.
Missouri valley	2.81	2.52	0.29 deficiency.
Northern slope	1.39	1.83	0.44 excess.
Middle slope	1.42	3.65	2.23 excess.
Southern slope	2.99	1.95	1.04 deficiency.
Southern plateau . . .	3.16	2.26	0.90 deficiency.
North Pacific coast . . .	0.78	0.08	0.70 deficiency.
Middle Pacific coast . .	0.02	0.00	0.02 deficiency.
South Pacific coast . . .	0.22	0.07	0.15 deficiency.
Mt. Washington, N.H. .	7.67	6.06	1.61 deficiency.
Pike's Peak, Col. . . .	4.81	2.22	2.59 deficiency.
Salt Lake City, Utah . .	0.88	0.62	0.26 deficiency.
Brownsville, Tex. . . .	5.94	1.97	3.97 deficiency.

The rainfall record can be best shown by the above table, which shows the unusual deficiency of the month in almost every section, which especially affected the crops in the south. Remarkably heavy rains were recorded in a few instances, — 10.38 inches at Griffin, Ga., in eight hours; and 8.14 inches at Kittyhawk, N.C., in four hours. In the cotton region the rainfall was much less than in August of last year, the amount at New Orleans being 2.70 inches, against 8.38 inches a year ago.

Local storms were not numerous, but were quite severe, especially in Iowa, on the 7th and 8th. On the 21st there was a veritable tornado in Minnesota, which devastated the town of Rochester, causing a loss of over thirty lives, and much damage to property.

Seven auroral displays occurred, but none were of especial note. The following electrical phenomenon is reported from Pike's Peak: —

"The observer on the summit of Pike's Peak, Col., reported that during a sleet and thunder storm, on the evening of the 4th, the anemometer cups revolved in circles of electric light. After a flash of lightning, the light encircling the cups became dim, but would soon regain its former brilliancy. The observer states, that, by holding up his hands, electric sparks would form on the ends of his fingers, and that his hair and clothing were full of them. A peculiar crackling noise was heard about the anemometer cups; and at the corners of the office building there were continuous sparks of bright light."

Earthquake-shocks occurred at Oakland, Cal., Carson City, Nev., St. Thomas, W.I. At the last-named place a tidal wave occurred on the 27th, and at San Francisco on the 27th and 28th. Earthquake waves, whose height was one foot, and time between crests forty minutes, were recorded on the Saucelito tide-gauge. It is supposed they were caused by the earthquake in Java on the 27th.

A dense smoke, due to forest-fires in Oregon and Washington, Idaho and Montana territories, prevailed during a greater part of the month, and extended on the Pacific coast as far south as Cape Mendocino, and thence eastward to eastern Montana, Dakota, and Minnesota.

The accompanying chart exhibits the mean pressure, temperature, and wind-direction, for the month.

THE INVENTION AND SPREAD OF BRONZE.

AT the thirteenth session of the German anthropological congress, held at Trier early in August, Professor Rudolph Virchow, the president, gave an address, the substance of which we quote from the *Frankfurter zeitung* of Aug. 11.

In beginning the president remarked, that, in the choice of Trier as the place of assembly for this year's congress, it was considered that the city and its surroundings were especially suited by their situation for the solution of the often-broached question of celts. The speaker then reviewed in a general way the present condition of anthropological research, paying especial attention to the first appearance of bronze in Europe. The question, when did the metal first come into use in our part of the world, is certainly one of the most important which anthropological science has to consider, and in order to provide the necessary material for its solution, wherever individual investigators or scientific societies are active, the territorial relations should be first examined, and, without drawing general conclusions, the localities or the strata in which the discoveries are made should be determined; for, however many investigations have already been undertaken in this branch of anthropology, the boundary where the stone age ceases and the metal age begins has not yet been definitely decided for any locality. A difficulty which arises in answering the question, does this or that settlement, this or that discovery, belong to the stone or bronze age, must not be passed in silence, since neglect of it has frequently led to mistakes. The difficulty is, that at one time, when metal was already common, stone implements were used both by poorer people, who were not able to obtain the expensive tools, and for ritualistic purposes. A circumstance which next comes into consideration, and which renders difficult in no little degree the determination of the epoch to which certain discoveries belong, is that the river-sand, silt, etc., in which the objects were found, often change their positions.

Passing to a general consideration of the bronze age, the speaker said that the answer to the question, where did the invention of this alloy originate, is one of the most important problems for anthropological research. There are two widely differing views on this subject: 1°, that of investigators who assume that bronze was invented at different times and in different places, independently of each other; and, 2°, that of those who assert that the invention was made at one place, and thence the use of the metal spread. In opposition to the first-mentioned assumption, is the fact that the bronze objects scattered over many regions show in their composition a considerable agreement, and, almost without exception, are composed of a mixture of nine parts copper and one part tin, as are by far the majority of those which are found in the countries lying between the Caucasus and Portugal. Even if the moisture of the earth and atmospheric influences affect the various components of the alloy in various ways, and a part of the copper is destroyed or altered, the bronze objects, as a whole, are affected in the same way; and the appearance of a very similar composition, in regions far removed from each other, points with convincing force to the conclusion that the invention of this mixture was made in one place, and its use was thence spread. Further, as to how bronze was introduced into Europe, we find also various opinions not very harmonious with each other. Some investigators naturally claim that it was through the Phoenicians, of whom we know that in ancient time they carried on a trade extending over the whole Mediterranean, and that while Cyprus, one of the chief centres for copper ore, — from this island copper (Latin, *cuprum*) received its name, — lay in their immediate neighborhood, they passed in their voyages the Pillars of Hercules, and visited the 'tin-island' (Great Britain). From the Phoenician trade-stations on the coast of the Mediterranean, among which the Massilian colony (Marseilles) played an important part, trade-roads into the interior were probably built. Many investigators suppose the spread of bronze was through commercial activity. Whether this view is true, is not easy to determine; since trade-settlements, which, as a rule, exert no, or at most only a transient, influence over the majority of the colonies and customs with which they come in contact, as soon as they cease to exist, can seldom be traced. The speaker, in his researches in Sicily, where, as is well known, the Carthaginians, also a people of Phoenician origin, were for a long time settled, could find no traces which indicated this settlement. Further, it is also well known that the trade supremacy which Pisa on the Mediterranean, and Genoa on the Black Sea, once exercised, has left on the coasts bordering these seas no traces worth mentioning. But, supposing that bronze was scattered by the commerce of the Phoenicians, it by no means proves that they were the inventors of this alloy. The speaker, on the whole, was much more inclined, with reservation of his decision, to place this invention farther to the east, in central Asia.

Besides the view just mentioned, which considers the commercial activity of the Phoenicians as the agent by which that advance in culture signalized by the use of metal implements was brought about, there is a theory lately advanced by Hochstetter, which deserves mention because it completely abandons the views formerly held. Hochstetter bases his assumptions on the discoveries in the graves at Hallstadt (first described by Sacken), and on certain discoveries at Watsch (Carniola), which show an interesting similarity to the former.[1] From these data, Hochstetter traces the identity of bronze manufacture in Hallstadt and upper Italy, and comes to the conclusion that this manufacture originated with the Aryans, and that the use of bronze for weapons and vessels had been common among this people a long time before the Aryan races wandered from their Asiatic home to Europe; while, at the same time, he denies the Etruscan origin of the findings at Hallstadt, Watsch, and Este, and assumes that the bronzes found in Italy, so far as they were not brought there by the Aryans inhabiting Italy, were imported from Greece.

Against these conclusions, surprising by their novelty, Virchow asserts, that in case the Aryans, in their wanderings to the west, had taken bronze with them, we must expect to find traces of its use on the highways, which they presumably followed in their

[1] A situla dug up at Watsch exhibits the same decoration as those found at Hallstadt, and contains, among other things, a representation of warriors, who are equipped with four different kinds of helmets, such as may be reconstructed from the discoveries at Hallstadt. Objects corresponding to the Watsch bronzes were found also in Este (North Italy).

advance; for example, in the valley of the Donau. Especially in regard to the Caucasus, his investigations in the region convinced him that no people already sufficiently civilized to employ metals could have passed over this range; and, on account of the geographical relations, we must assume that the Aryan peoples first divided in central Asia, and separated widely along the northern coast of the Aral and Caspian seas, and then proceeded through modern Russia, where the characteristic bronzes are not found, or westward through Asia Minor. Once in Greece, it is highly probable that Italy was their next step. A fact brought forward by Hochstetter in support of his theory — viz., the lack of ribbed bronzes, Mestea dicordoni — has proved a mistake. A point of attack is presented by the same investigator, in his assertion that the discoveries at Hallstadt do not date back of the second millenary before the Christian era, and immediately preceded the Roman civilization; and that, at the time of the subjugation of Noricum by Rome, the manufacture of bronze already existed.

At the close of his address, Virchow merely touched upon other anthropological questions, and pointed out that philology and archeology alone were not in condition to relieve the darkness which still concealed the invention and spread of bronze; and that somatic anthropology, i.e., the investigation of the physical constitution of the peoples under consideration, as seen from the bones preserved to us, may here have a final word to say, and may, perhaps, answer the important question, whether the cultivation of central Europe is to be traced to the influence of two different families, or to only one, the Aryan.

THE VEGETATION OF THE CARBONIFEROUS AGE.[1]

MUCH of the second decade of my life was spent in the practical pursuit of geology in the field; and throughout most of that period I enjoyed almost daily intercourse with William Smith, the father of English geology. But, in later years, circumstances restricted my studies to the paleontological side of the science: hence I was anxious that the council of the British association should place in this chair some one more familiar than myself with the later developments of geographical geology. But my friend, Professor Bonney, failing to recognize the force of my objections, intimated to me that I might render some service to the association by placing before you a sketch of the present state of our knowledge of the vegetation of the carboniferous age.

This being a subject respecting which I have formed some definite opinions, I am going to act upon the suggestion. To some this may savor of 'shop-talk;' but such is often the only talk which a man can indulge in intelligently: and to close his mouth on his special themes may compel him either to talk nonsense or to be silent.

Whilst undertaking this task, I am alive to the difficulties which surround it, especially those arising from the wide differences of opinion amongst paleobotanists on some fundamental points. On some of the most important of these there is a substantial agreement between the English and German paleontologists. The dissentients are chiefly, though not entirely, to be found amongst those of France, who have, in my humble opinion, been unduly influenced by what is in itself a noble motive; viz., a strong reverence for the views of their illustrious teacher, the late Adolphe Brongniart. Such a tendency speaks well for their hearts; though it may, in these days of rapid scientific progress, seriously mislead their heads. I shall, however, endeavor to put before you faithfully the views entertained by my distinguished French friends, M. Renault, M. Grand-Eury, and the Marquis of Saporta, giving, at the same time, what I deem to be good reasons for not agreeing with them. I believe that many of our disagreements arise from geological differences between the French carboniferous strata and those in our own islands. There are some important types of carboniferous plants that appear to be much better represented amongst us than in France: hence we have, I believe, more abundant material than the French paleontologists possess, for arriving at sound conclusions respecting these plants. We have rich sources, supplying specimens in which the internal organization is preserved, in eastern Lancashire and western Yorkshire, Arran, Burntisland, and other scattered localities: France has equally rich localities at Autun and at St. Étienne. But some important difference exists between these localities. The French objects are preserved in an impracticable siliceous matrix, extremely troublesome to work, except in specimens of small size: ours, on the other hand, are chiefly embedded in a calcareous material, which, whilst it preserves the objects in an exquisite manner, does not prevent our dissecting examples of considerable magnitude. But, besides this, we are much richer in huge Lepidodendroid and Sigillarian trees, with their Stigmarian roots, than the French are: hence we have a vast mass of material illustrating the history of these types of vegetation, in which they seem to be seriously deficient. This fact alone appears to me sufficient to account for many of the wide differences of opinion that exist between us, respecting these trees. My second difficulty springs out of the imperfect state of our knowledge of the subject. One prominent cause of this imperfection lies in the state in which our specimens are found. They are not only too frequently fragmentary, but most of those fragments only present the external forms of the objects. Now, mere external forms of fossil plants are somewhat like similarities of sound in the comparative study of languages: they are too often unsafe guides. On the other hand, microscopic internal organizations in the former subjects are like grammatical indentities in the latter one: they indicate deep affinities that promise to guide the student safely to philosophical

[1] Opening address before the section of geology of the British association for the advancement of science. By Prof. W. C. WILLIAMSON, LL.D., F.R.S., president of the section. From advance sheets kindly furnished by the editor of *Nature*.

conclusions. But the common state in which our fossil plants are preserved presents a source of error that is positive as well as negative. Most of those from our coal-measures consist of inorganic shale, sandstone, or ironstone, invested by a very thin layer of structureless coal. The surface of the inorganic substance is moulded into some special form, dependent upon structural peculiarities of the living plants; which structures were sometimes external, sometimes internal, and sometimes intermediate ones. Upon this inorganic cast we find the thin film of structureless coal, which, though of organic origin, is practically as inorganic as the clay or sandstone which it invests; but its surface displays specific sculpturings, which are apt to be regarded as always representing the outermost surface of the plant when living, whereas this is not always the case. That the coaly film is a relic of the carbonaceous substance of the living plant is unquestionable; but the thinnest of these films are often the sole remaining representatives of structures that must originally have been many inches, and in some instances even many feet, in thickness. In such cases most of the organic material has been dissipated, and what little remains has often been consolidated in such a way that it is merely moulded upon the sculptured inorganic substance which it covers, and hence affords no information respecting the exterior of the fossil when a living organism. It is, in my opinion, from specimens like these, that the smooth bark of the Calamite has been credited with a fluted surface, and the Trigonocarpons with a merely triangular exterior and a misleading name, as it long caused the inorganic casts known as Sternbergiae to be deemed a strange form of plant, that had no representative amongst living types. In other cases the outermost surface of the bark is brought into close contact with the surface of the vascular cylinder. I have a Stigmaria in which the bases of the rootlets appear to be planted directly upon that cylinder, the whole of the thick intermediate bark having disappeared. In other examples, that vascular zone has also gone. Thus the innermost and outermost surfaces of a cylinder, originally many inches apart, are, through the disappearance of the intermediate structures, brought into close approximation. In such cases, leaves and other external appendages appear to spring directly from what is merely an inorganic cast of the interior of the pith. I believe that many of our Calamites are in this condition. Such examples have suggested the erroneous idea that the characteristic longitudinal flutings belong to the exterior of the bark.

Fungi. — Entering upon a more detailed review of our knowledge of the carboniferous plants, and commencing at the bottom of the scale, we come to the lowly group of the fungi, which are unquestionably represented by the Peronosporites antiquarius[1] of Worthington Smith. There seems little reason for doubting that this is one of the phycomycetous fungi, possibly somewhat allied to the Saprolegnieae; but since we have, as yet, no evidence respecting its fructification, these closer relationships must for the present remain undetermined. So far as I know, this is the only fungus satisfactorily proved to exist in the carboniferous rocks, unless the Excipulites Neesii of Goeppert, and one or two allied forms, belong to the fungoid group. The Polyporites Bowmanni is unquestionably a scale of a holoptychian fish.

Algae. — Numerous objects supposed to belong to this family have been discovered in much older rocks than carboniferous ones. The subject is a thorny one. That marine plants of some kind must have existed simultaneously with the molluscous and other plant-eating animals of paleozoic times, is obviously indisputable; but what those plants were is another question. The widest differences of opinion exist in reference to many of them. A considerable number of those recognized by Schimper, Saporta, and other paleobotanists, are declared by Nathorst to be merely inorganic tracks of marine animals; and, in the case of many of these, I have little doubt that the Swedish geologist is right. Others have been shown to be imperfectly preserved fragments of plants of much higher organization than algae, branches of conifers even being included amongst them. I have, as yet, seen none of carboniferous age that could be indisputably identified with the family of algae, though there are many that look like and may probably be such. The microscope alone can settle this question, though even this instrument fails to secure unity of opinion in the case of Dawson's Prototaxites; and no other of the supposed seaweeds hitherto discovered have been sufficiently well preserved to bear the microscopic test: hence I think that their existence in carboniferous rocks can only be regarded as an unproven probability. Mere superficial resemblances do not satisfy the severe demands of modern science, and probabilities are an insufficient foundation upon which to build evolutionary theories.

Seeing what extremely delicate cell-structures *are* preserved in the carboniferous beds, it cannot appear other than strange that the few imperfect fungoid relics just referred to constitute the only terrestrial cellular cryptogams that have been discovered in the carboniferous strata. The Darwinian doctrine would suggest that these lower forms of plant-life ought to have abounded in that primeval age; and that they were capable of being preserved is proved by the numerous specimens met with in tertiary deposits. Why we do not find such in the paleozoic beds is still an unsolved problem.

Vascular cryptogams. — The vascular cryptogams, next to be considered, burst upon us almost suddenly, and in rich profusion, during the Devonian age. They are equally silent in the Devonian and carboniferous strata as to their ancestral descent.

Ferns. — The older taxonomic literature of paleozoic fern-life is, with few exceptions, of little scientific value. Hooker and others have uttered in vain wise protests against the system that has been pursued. Small fragments have had generic and specific names assigned to them, with supreme indifference to the study of morphological variability amongst living types. The undifferentiated tip of a terminal

[1] Memoir xi. p. 299.

pinnule has had its special name, whilst the more developed structures forming the lower part of a frond have supplied two or three more species. Then the distinct forms of the fertile fronds may have furnished additional ones, whilst a further cause of confusion is seen in the wide difference existing between a young, half-developed seedling and the same plant at an advanced stage of its growth. Any one who has watched the development of a young Polypodium aureum can appreciate this difference. Yet, in the early stages of paleontological research, observers could scarcely have acted otherwise than as they did, in assigning names to these fragments, if only for temporary working purposes. Our error lies in misunderstanding the true value of such names. At present the study of fossil ferns is affording some promise of a newer and healthier condition. We are slowly learning a little about the fructification of some species, and the internal organization of others. Facts of these kinds, cautiously interpreted, are surer guides than mere external contours. Unfortunately, such facts are, as yet, but few in number; and, when we have them, we are too often unable to identify our detached sporangia, stems, and petioles, with the fronds of the plants to which they primarily belonged.

That all the carboniferous plants included in the genera Pecopteris, Neuropteris, and Sphenopteris, are ferns, appears to be most probable; but what the true affinities of the objects included in these ill-defined genera may be, is very doubtful. Here and there we obtain glimpses of a more definite kind. That the Devonian Palaeopteris hibernica is an hymenophyllous form appears to be almost certain; and, on corresponding grounds, we may conclude that the carboniferous forms, Sphenopteris trichomanoides, S. Humboldtii,[1] and Hymenophyllum Weissii,[2] belong to the same group. The fructification of the two latter leaves little room for doubting their position, whilst the foliage of some other species of Sphenopteris is suggestive of similar conclusions; but, until their fructification is discovered, this cannot be determined. An elegant form of Sphenopteris (S. tenella, Brong.; S. lanceolata of Gutbier), recently described by Mr. Kidson of Stirling, abundantly justifies caution in dealing with these Sphenopterides. This plant possesses a true sphenopteroid foliage, but its fructification is that of a marattiaceous danaid. The sporangia are elongated vertically, and have the round terminal aperture of both the recent and fossil Danaiae, — a group of plants far removed from the hymenophyllaceous type of sphenopterid already referred to.

Whether or not this Sphenopteris was really marattiaceous in other features than in its fructification, is uncertain; but I think that we have indisputably got stems and petioles of Marattiaceae from the carboniferous strata. My friend M. Renault, and I, without being aware of the fact, simultaneously studied the Medullosa elegans of Cotta. This plant was long regarded as the stem of a true monocotyledon, — a decision the accuracy of which was doubted first by Brongniart, and afterwards by Binney. M. Renault's

[1] Schimper, vol. I. p. 408. [2] *Ibid.*, p. 415.

memoir, and my part vii., appeared almost simultaneously. We then found that we had alike determined the supposed monocotyledon to be not only a fern, but to belong to the peculiarly aberrant group of the Marattiaceae. As yet we know nothing of its foliage and fructification.

M. Grand-Eury has figured [1] a remarkable series of ferns from the coal-measures of the basin of the Loire, the sporangia of which exhibit marked resemblances to those of the Marattiaceae. This is especially the case with his specimens of Asterotheca and Scolecopteris,[2] as also with his Pecopteris Marattiaetheca, P. Angiotheca, and P. Danaeaetheca; but there is some doubt as to the dehiscence of the sporangia of these plants: hence their marattiaecous character is not absolutely established.

That the coal-measures contain the remains of arborescent ferns has long been known, especially from their abundance at Autun. In Lancashire I have only met with the stems or petioles of one species preserving their internal organization.[3] The Rev. H. H. Higgins obtained stems that appear to have been tree-ferns from Ravenhead, in Lancashire; and it is probable that most of the plants included in the genera Psaronius, Caulopteris, and Protopteris, are also tree-ferns.

There yet remains another remarkable group of ferns, the sporangia of which are known to us through the researches of M. Renault. In these the fertile pinnules are more or less completely transmuted into small clusters of oblong sporangia. In one case, M. Renault believes that he has identified these organs with a stem or petiole of a type not uncommon at Oldham and Halifax, belonging to Corda's genus Zygopteris. Renault has combined this with some others to constitute his group of Botryopteridées, an altogether extinct and generalized type. This review shows, that whilst forms identifiable with the Hymenophyllaceae and Marattiaceae existed in the carboniferous epoch, and we find here and there traces of affinities with some other more recent types, most of the carboniferous ferns are generalized primeval forms, which only become differentiated into later ones in the slow progress of time.

Equisetaceae and Asterophylliteae (*Brongniart*), *Calamariae* (*Endlicher*), *Equisetineae* (*Schimper*). — Confusion culminates in the history of this variously named group: hence the subject is a most difficult one to treat in a concise way. The confusion began when Brongniart separated the plants contained in the group into two divisions, one of which (Équisétacés) he identified with the living equisetums, and the other (Astérophyllitées) he regarded as being gymnospermous dicotyledons. To Schimper belongs the merit, as I believe it to be, of steadily resisting this division; nevertheless, paleobotanists are still

[1] Flore carbonifère du Départment de la Loire et du centre de la France.

[2] *Loc. cit.*, tab. viii., figs. 1-5.

[3] Psaronius Renaultii, Memoir vii., p. 10; and Memoir xii., pl. iv., fig. 16. These and other similar references are to my series of memoirs on the organization of the fossil plants of the coal-measures, published in the Philosophical transactions.

separated into two schools on the subject. Dawson, Renault, Grand-Eury, and Saporta adhere to the Brongniartian idea; whilst the British and German paleontologists have always adopted the opposite view, rejecting the idea that any of these plants were other than cryptogams.

A fundamental feature of the entire group is in the fact that their foliar appendages, however morphologically and physiologically modified, are arranged in nodal verticils. This appears to be the only characteristic which the plants possess in common.

Calamites and Calamodendron.— In his 'Prodrome' (1828), and in his later 'Végétaux fossiles,' Brongniart adopted the former of these generic names as previously employed by Suckow, Schlotheim, Sternberg, and Artis. It was only in his 'Tableau des genres de végétaux fossiles' (Dictionnaire universel d'histoire naturelle, 1849) that he divided the genus, introducing the second name to represent what he believed to be the gymnospermous division of the group. A long series of investigations, extending over many years, has convinced me that no such gymnospermous type exists.[1] The same conclusion has more recently been arrived at by Vom c. M. D. Stur,[2] after studying many continental examples in which structure is preserved. What I regard as *an* error appears to have had an intelligible origin, — the fertile source of similar errors in other groups.

Nearly all the Calamitean fossils found in shales and sandstones consist of an inorganic, superficially fluted substance, coated over with a thin film of structureless coal (see 'Histoire des végétaux fossiles,' vol. i. pl. 22); *the latter being exactly moulded upon and following the outlines of the inorganic fluted cast that underlies it.* Brongniart, and those who adopt his views, believe that the external surface of this coal-film exactly represents the corresponding external surface of the original plant: hence the conclusion was arrived at, that the plant had a very large central fistular cavity, surrounded by a very thin layer of cellular and vascular tissues, as in some living equisetums. On the other hand, Brongniart also obtained some specimens of what he primarily believed to be Calamites, in which the central pith was surrounded by a thick layer of woody tissue arranged in radiating laminated wedges, separated by medullary rays. The exogenous structure of this woody zone was too obvious to escape his practised eye. But, not supposing it possible that any cryptogam could possess a cambium-layer and an exogenous mode of development, Brongniart came to the conclusion that the thin-walled specimens found in the shales and sandstones were true Equisetaceae, those with the thick, woody cylinders being mere exogens of another type. His conclusion that they were gymnosperms was a purely hypothetical one, since justified by no one feature of their organization.

My researches, based upon a vast number of specimens of all sizes, from minute twigs little more than the thirtieth of an inch in diameter to thick stems

[1] Memoirs i., ix., and xii.

[2] Zur morphologie der calamarien.

at least thirteen inches across, led me to the conclusion that we have but one type of calamite, and that the differences which misled Brongniart are merely due to variations in the mode of their preservation.[1] It became clear to me that the outer surface of the coaly film in the specimens preserved in the shales and sandstones did *not* represent the outer surface of the living plant, but was only a fractional remnant of the carbon of that plant, which had undergone a complete metamorphosis. The greater part of what originally existed had disappeared, probably in a gaseous state; and the little that remained, displaying no organic structure, *had been moulded upon the underlying inorganic cast of the medullary cavity.* This cast is always fluted longitudinally, and constructed transversely at intervals of varying lengths. Both these features were due to impressions made by the organism upon the inorganic sand or mud filling the medullary cavity whilst it was in a plastic state, and which subsequently became more or less hardened; the longitudinal grooves being caused by the pressure of the inner angles of the numerous longitudinally vascular wedges, and the transverse ones partly by the remains of a cellular nodal diaphragm which crossed the fistular medullary cavity, and partly by a centripetal encroachment of the vascular zone at each of the same points.[2]

My cabinets contain an enormous number of sections of these plants, in which the minutest details of their organization are exquisitely preserved. These specimens, as already observed, show their structure in every stage of their growth, — from the minutest twigs, to stems more than a foot in diameter. Yet these various examples are all, without a solitary exception, constructed upon one common plan. That plan is an extremely complicated one, — far too complex to make it in the slightest degree probable that it could co-exist in two such very different orders of plants as the Equisetaceae and the Gymnospermae. Yet, though very complex, it is, even in many of its minuter details, unmistakably the plan upon which the living equisetums are constructed. The resemblances are too clear, as well as too remarkable, in my mind, to leave room for any doubt on this point. The great differences are only such as necessarily resulted from the gradual attainment of the arborescent form so unlike the lowly herbaceous one of their living representatives. On the other hand, no living gymnosperm possesses an organization that *in any solitary feature* resembles that of the so-called Calamodendra. The two have absolutely nothing in common: hence the conclusion that these Calamodendra were gymnospermous plants is as arbitrary an assumption as could possibly be forced upon science, — an assumption that no arguments derived from the merely external aspects of structureless specimens could ever induce me to accept.

These Calamites exhibit a remarkable morphological characteristic, which presents itself to us here for the first time, but which we shall find recurs in other paleozoic forms. Some of our French botani-

[1] Memoirs i. and ix.

[2] See Memoir i., pl. xxiv., fig. 10; and pl. xxvi., fig. 24.

cal friends group the various structures contained in plants into several 'appareils,'[1] distinguished by the functions which those structures have to perform. Amongst others, we find the 'appareil de soutiens,' embracing those hard, woody tissues which may be regarded as the supporting skeleton of the plant, and the 'appareil conducteur,' which M. van Tieghem describes as composed of two tissues, — "le tissu criblé qui transporte essentiellement les matières insolubles, et le tissu vasculaire qui conduit l'eau et les substances dissoutes." Without discussing the scientific limits of this definition, it suffices for my present purpose. In nearly all flowering plants these two 'appareils' are more or less blended. The supporting wood-cells are intermingled in varying degrees with the sap-conducting vessels. It is so, even in the lower gymnosperms; and in the higher ones these wood-cells almost entirely replace the vessels. It is altogether otherwise with the fossil cryptogams. The vascular cylinder in the interior of the Calamites, for example, consists wholly of *barred* vessels, a slight modification of the scalariform type so common in all cryptogams. No trace of the 'appareil de soutiens' is to be found amongst them. The vessels are, in the most definite sense, the 'appareils conducteurs' of these plants. No such absolutely undifferentiated unity of tissue is to be found in any living plants other than cryptogams.

But these Calamites, when living, towered high into the air. My friend and colleague, Professor Boyd Dawkins, recently assisted me in measuring one found in the roof of the Moorside colliery, near Ashton-under-Lyne, by Mr. George Wild, the very intelligent manager of that and some neighboring collieries. The flattened specimen ran obliquely along the roof, each of its two extremities passing out of sight, burying themselves in the opposite sides of the mine. Yet the portion which we measured was thirty feet long; its diameter being six inches at one end, and four inches and a half at the other. The mean length of its internodes at its broader end was three inches, and at its narrower one an inch and a half. What the real thickness of this specimen was when all its tissues were present, we have no means of judging; but the true diameter of the cylinder represented by the fossil when uncompressed has been only four inches at one end of the thirty feet, and two inches and a half at the other. Whatever its entire diameter when living, the vascular cylinder of this stem must have been at once tall and slender, and consequently must have required some 'appareil de soutien' such as its exogenous vascular zone did not supply. This was provided in a very early stage of growth by the introduction of a second cambium-layer into the bark; which, though reminding us of the cork-cambium in ordinary exogenous stems, produced, not cork, but prosenchymatous cells.[2] In its youngest state, the bark of the Calamites was a very loose cellular parenchyma; but in the older stems much of this parenchyma became enclosed in the prosenchymatous tissue referred to, and which appears to have constituted the greater portion of the matured bark. The sustaining skeleton of the plant, therefore, was a hollow cylinder, developed centrifugally on the inner side of an enclosing cambium-zone. That this cambium-zone must have had some protective periderm external to *it*, is obvious; but I have not yet discovered what it was like. We shall find a similar cortical provision for supporting lofty cryptogamous stems in the Lepidodendra and Sigillariae.

[1] Van Tieghem, Traité de botanique, p. 679.

[2] Memoir ix., pl. xx., figs. 14, 15, 18, 19, and 20.

The carboniferous rocks have furnished a large number of plants having their foliage arranged in verticils, and which have had a variety of generic names assigned to them. Such are Asterophyllites, Sphenophyllum, Annularia, Bechera, Hippurites, and Schizoneura. Of these genera, Sphenophyllum is distinguished by the small number of its wedge-shaped leaves; and the structure of its stems has been described by M. Renault. Annularia is a peculiar form, in which the leaves forming each verticil, instead of being all planted at the same angle upon the central stem, are flattened obliquely nearly in the plane of the stem itself. Asterophyllites differs from Sphenophyllum chiefly in the larger number and in the linear form of its leaves. Some stems of this type have virtually the same structure[1] as those of Sphenophyllum, — a structure which differs widely from that of the Calamites, and of which, consequently, these plants cannot constitute the leaf-bearing branches. But there is little doubt that true calamitean branches have been included in the genus Asterophyllites. I have specimens, for which I am indebted to Dr. Dawson, which I should unhesitatingly have designated Asterophyllites but for my friend's positive statement that he detached them from stems of a calamite. Of the internal organization of the stems of the other genera named, we know nothing.

It is a remarkable fact, that notwithstanding the number of young calamitean shoots that we have obtained from Oldham and Halifax, in which the structure is preserved, we have not met with one with the leaves attached. This is apparently due to the fact that most of the specimens are decorticated ones. We have a sufficient number of corticated specimens to show us what the bark was, but such specimens are not common. They clearly prove, however, that their bark had a smooth, and not a furrowed, external surface.

There yet remains for consideration the numerous reproductive strobili, generally regarded as belonging to plants of this class, Equisetinae. We find some of these strobili associated with stems and foliage of known types, as in Sphenophyllum;[2] but we know nothing of the internal organization of these sphenophylloid strobili. We have strobili connected with stems and foliage of Annularia,[3] but we are equally ignorant of the organization of these. So far as that

[1] Memoir, part v., pl. i.–v.; and part ix., pl. xxi., fig. 32.

[2] Lesquereux, Coal flora of Pennsylvania, pl. ii., fig. 687.

[3] Ueber die fruchtähren von Annularia sphenophylloides. Von T. Sterzel. Zeitschr. d. deutschen geolog. gesellschaft, Jahrg. 1882.

organization can be ascertained from Sterzel's specimen, it seems to have alternating sterile and fertile bracts, with the sporangia of the latter arranged in fours, as in Calamostachys.[1] On the other hand, we are now very familiar with the structure of the Calamostachys Binneana, the prevalent strobilus in the calcareous nodules found in the lower coal-measures of Lancashire and Yorkshire. It has evidently been a sessile spike, the axial structures of which were trimerous[2] (rarely tetramerous), having a cellular medulla in its centre. Its appendages were exact multiples of those numbers. Of the plant to which it belonged we know nothing. On the other hand, we have examples supposed to be of the same genus, as C. paniculata[3] and C. polystachya,[4] united to stems with asterophyllitean leaves; but whether or not these fruits have the organization of C. Binneana, we are unable to say.

We are also acquainted with the structure of the two fruits belonging to the genera Bruckmannia[5] and Volkmannia.[6] This latter term has long been very vaguely applied.

There still remain the genera Stachannularia, Palaeostachya, Macrostachya, Cingularia, Huttonia, and Calamitina, all of which have the phyllomes of their strobili fertile and sterile, arranged in verticils, and some of them display asterophyllitean foliage. But these plants are only known from structureless impressions. That all these curious spore-bearing organisms have close affinities with the large group of the equisetums cannot be regarded as certain; but several of them undoubtedly have peculiarities of structure suggestive of relations with the Calamites. This is especially observable in the longitudinal canals found in the central axis of each type, apparently identical with what I have designated the internodal canals of the Calamites.[7] The position and structure of their vascular bundles suggest the same relationship, whilst in many the position of the sporangia and sporangiophores is eminently equisetiform. Renault's Bruckmannia Grand-Euryi and B. Decaisnei, and a strobilus which I described in 1870,[8] exhibit these calamitean affinities very distinctly.

One strobilus which I described in 1880[9] must not be overlooked. As is well known, all the living forms of esquisetaceous plants are isosporous. We only discover heterosporous vascular cryptogams amongst the Lycopodiaceae and the Rhizocarpae. My strobilus is identical, in every detailed feature of its organization, with the common Calamostachys Binneana, excepting that it is heterosporous; having microspores in its upper, and macrospores in its lower part, — a state of things suggestive of some link between the Equisetinae and the heterosporous Lycopodiaceae.

Lycopodiaceae. — This branch of my subject suggests memories of a long conflict, which, though it is virtually over, still leaves here and there the groundswell of a stormy past. At the meeting of the British association at Liverpool, in 1870, I first announced that a thick, secondary, exogenous growth of vascular tissue existed in the stems of many carboniferous cryptogamic plants, especially in the calamitean and lepidodendroid forms. But at that time the ideas of M. Brongniart were so entirely in the ascendant, that my notions were rejected by every botanist present. Though the illustrious French paleontologist knew that such growths existed in Sigillariae and in what he designated Calamodendra, he concluded, that, *de facto*, such plants could not be cryptogams. Time, however, works wonders. Evidence has gradually accumulated, proving, that, with the conspicuous exception of the ferns, nearly every carboniferous cryptogam was capable of developing such zones of secondary growth. The exceptional position of the ferns still appears to be as true as it was when I first proclaimed their exceptional character at Liverpool. At that time I was under the impression that the secondary wood was only developed in such plants as attained to arboreal dimensions; but I soon afterwards discovered that it occurred equally in many small plants like Sphenophyllum, Asterophyllites, and other diminutive types.

After thirteen years of persevering demonstration, these views, at first so strongly opposed, have found almost universal acceptance; nevertheless, there still remain some few who believe them to be erroneous ones. In the later stages of this discussion the botanical relations subsisting between Lepidodendron, Sigillaria, and Stigmaria, have been the chief themes of debate. In this country we regard the conclusion, that Stigmaria is not only a root, but the root alike of Lepidodendron and Sigillaria, as settled beyond all dispute. Nevertheless, M. Renault and M. Grand-Eury believe that it is frequently a leaf-bearing rhizome, from which aerial stems are sent upwards. I am satisfied that there is not a shadow of foundation for such a belief. The same authors, along with their distinguished countryman the Marquis de Saporta, believe with Brongniart that it is possible to separate Sigillaria widely from Lepidodendron. They leave the latter plant amongst the lycopods, and elevate the former to the rank of a gymnospermous exogen. I have in vain demonstrated the existence of a large series of specimens of the same species of plant, young states of which display all the essential features of structure which they believe to characterize Lepidodendron; whilst, in its progress to maturity, every stage in the development of the secondary wood, regarded by them as characteristic of a Sigillaria, can be followed step by step.[1] Nay, more. My cabinet contains specimens of young dichotomously branching twigs, on

[1] M. Renault has described a strobilus under the name of Annularia longifolia, but which appears to me very distinct from that genus.

[2] It is an interesting fact, that transverse sections of the strobili of Lycopodium alpinum exhibit a similar trimerous arrangement, though differing widely in the positions of its sporangia.

[3] Weiss, Abhandlungen zur geologischen specialkarte von Preussen und Thürinaischen Staaten, taf. xiii., fig 1.

[4] *Idem*, taf. xvi., figs. 1, 2.

[5] Renault, Annales de sciences naturelles, bot., tome iii., pl. iii.

[6] *Idem*, pl. ii.

[7] Memoir i.

[8] Memoirs of the literary and philosophical society of Manchester, 3d series, vol. iv. p. 248.

[9] Memoir xi., pl. liv., figs. 23, 24.

[1] Memoir xi., plates xlvii.–lii.

which one of the two diverging branches has only the centripetal cylinder of the Lepidodendron, whilst the other has begun to develop the secondary wood of the Sigillaria.[1]

The distinguished botanist of the Institut, Ph. van Tieghem, has recently paid some attention to the conclusions adopted by his three countrymen in this controversy, and has made an important advance upon those conclusions, in what I believe to be the right direction. He recognizes the lycopodiaceous character of the Sigillariae, and their close relations to the Lepidodendra;[2] and he also accepts my demonstration of the unipolar, and consequently lycopodiaceous, character of the fibro-vascular bundle of the stigmarian rootlet, — a peculiarity of structure of which M. Renault has hitherto denied the existence. But along with these recognitions of the accuracy of my conclusions, he gives fresh currency to several of the old errors relating to parts of the subject to which he has not yet given personal attention. Thus he considers that the Sigillariae, though closely allied to the Lepidodendra, are distinguished from them by possessing the power of developing the centrifugal or exogenous zone of vascular tissue already referred to. He characterizes the Lepidodendra as having '*un seul bois centripète*,' notwithstanding the absolute demonstrations to the contrary contained in my Memoir xi. Dealing with the root of Sigillaria, which in Great Britain, at least, is the well-known Stigmaria ficoides, following Renault, he designates it a 'rhizome,' limiting the term 'root' to what we designate the rootlets. He says, "Le rhizome des sigillaires a la même structure que la tige aérienne, avec des bois primaires tantôt isolés à la périphérie de la moelle, tantôt confluents au centre et en un ax plein; seulement les fasceaux libéro-ligneux secondaires y sont séparés par de plus larges rayons," etc.

Now, Stigmaria, being a root, and not a rhizome, contains no representative of the primary wood of the stem. This latter is, as even M. Brongniart so correctly pointed out long ago, the representative of the medullary sheath; and the fibro-vascular bundles which it gives off are all foliar ones, as is the case with the bundles given off by this sheath in all exogenous plants. But in the Lepidodendra and Sigillariae, as in all living exogens, it is not prolonged into the root. In the latter, as might be expected *a priori*, we only find the secondary or exogenous vascular zone. Having probably the largest collection of sections of Stigmariae in the world, I speak unhesitatingly on these points. M. van Tieghem further says, "La tige aérienne part d'un rhizome rameux très-développé nommé Stigmaria, sur lequel s'insèrent à la fois de petites feuilles et des racines parfois dichotomées." I have yet to see a solitary fact justifying the statement that leaves are intermingled with the rootlets of Stigmaria. The statement rests upon an entire misinterpretation of sections of the fibro-vascular bundles supplying those rootlets, and an ignorance of the nature and positions of the rootlets themselves. More than forty years have elapsed since John Eddowes Bowman first demonstrated that the Stigmariae were true roots; and every subsequent British student has confirmed Bowman's accurate determination.

[1] Memoir xi., pl. xlix., fig. 8. [2] Traité de botanique, p. 304.

M. Lesquereux informs me that his American experiences have convinced him that Sigillaria is lycopodiaceous. Dr. Dawson has now progressed so far in the same direction as to believe that there exists a series of sigillarian forms which link the Lepidodendra on the one hand with the gymnospermous exogens on the other. As an evolutionist, I am prepared to accept the possibility that such links may exist. They certainly do, so far as the union of Lepidodendron with Sigillaria is concerned. I have not yet seen any from the higher part of the chain that are absolutely satisfactory to me, but Dr. Dawson thinks that he has found such. I may add, that Schimper and the younger German school have always associated Sigillaria with the Lycopodiaceae; but there are yet other points under discussion connected with these fossil lycopods.

M. Renault affirms that some forms of Halonia are subterranean rhizomes, and the late Mr. Binney believed that Haloniae were the roots of Lepidodendron. I am not acquainted with a solitary fact justifying either of these suppositions, and unhesitatingly reject them. We have the clearest evidence that some Haloniae, at least, are true terminal, and, as I believe, strobilus-bearing, branches of various lepidodendroid plants; and I see no reason whatever for separating Halonia regularis from those whose fruit-bearing character is absolutely determined. Its branches, like the others, are covered throughout their entire circumference, and in the most regularly symmetrical manner, with leaf-scars, — a feature wholly incompatible with the idea of the plant being either a root or a rhizome. M. Renault has been partly led astray in this matter by misinterpreting a figure of a specimen published by the late Mr. Binney. That specimen being now in the museum of Owens college, we are able to demonstrate that it has none of the features which M. Renault assigns to it.

The large, round or oval, distichously arranged scars of Ulodendron have long stimulated discussion as to their nature. This, too, is now a well-understood matter. Lindley and Hutton long ago suggested that they were scars whence cones had been detached, — a conclusion which was subsequently sustained by Dr. Dawson and Schimper,[1] and which structural evidence led me also to support. The matter was set at rest by Mr. d'Arcy Thompson's discovery of specimens with the strobili *in situ*. Only a small central part of the conspicuous cicatrix characterizing the genus represented the area of organic union of the cone to the stem. The greater part of that cicatrix has been covered with foliage, which, owing to the shortness of the cone-bearing branch, was compressed by the base of the cone. The large size of many of these biserial cicatrices on old stems has been due to the considerable growth of the stem subsequently to the fall of the cone.

Our knowledge of the terminal branches of the

[1] Memoir ii., p. 222.

large-ribbed Sigillariae is still very imperfect. Paleontologists who have urged the separation of the Sigillariae from the Lepidodendra have attached weight to the difference between the longitudinally ridged and furrowed external bark of the former plants, along which ridges the leaf-scars are disposed in vertical lines, and the diagonally arranged scars of Lepidodendron. They have also dwelt upon the alleged absence of branches from the sigillarian stems. I think that their mistake, so far as the branching is concerned, has arisen from their expectation that the branches must necessarily have had the same vertically grooved appearance and longitudinal arrangement of the leaf-scars as they observed in the more aged trunks: hence they have probably *seen* the branches of Sigillariae without *recognizing* them. Personally, I believe this to have been the case. I further entertain the belief, that the transition from the *vertical* phyllotaxis, or leaf-arrangement, of the sigillarian leaf-scars, to the *diagonal* one of the Lepidodendra, will ultimately be found to be effected through the subgenus Favularia, in many of which the diagonal arrangement becomes quite as conspicuous as the vertical one. This is the case even in Brongniart's classic specimen of Sigillaria elegans, long the only fragment of that genus known, which preserved its internal structure. The fact is, the shape of the leaf-scars, as well as their proximity to each other, underwent great changes as lepidodendroid and sigillarian stems advanced from youth to age. Thus Presl's genus Bergeria was based on forms of lepidodendroid scars which we now find on the terminal branches of unmistakable lepidodendra.[1] The phyllotaxis of Sigillaria, of the type of S. occulata, passes by imperceptible gradations into that of Favularia. In many young branches the leaves were densely crowded together; but the exogenous development of the interior of the stem, and its consequent growth both in length and thickness, pushed these scars apart at the same time that it increased their size and altered their shape. We see precisely the same effects produced upon the large fruit-scars of Ulodendron by the same causes. The carboniferous lycopods were mostly arborescent; but some few dwarf forms, apparently like the modern Selaginellae, have been found in the Saarbrücken coal-fields. Many, if not all, the arborescent forms produced secondary wood by means of a cambium-layer, as they increased in age. In the case of some of them,[2] this was done in a very rudimentary manner; nevertheless, sufficiently so to demonstrate what is essential to the matter, viz., the existence of a cambium-layer producing 'centrifugal growth of secondary vascular tissue.'

As already pointed out in the case of the Calamites, the vascular axis of these Lepidodendra was purely an 'appareil conducteur,' unmixed with any wood-cells: hence the 'appareil de soutien' had to be supplied elsewhere. This was done as in the Calamites: a thick, persistent, hypodermal zone of meristem[3] developed a layer of prismatic prosenchyma of enormous thickness,[1] which incased the softer structures in a strong cylinder of self-supporting tissue. We have positive evidence that the fructification of many of these plants was in the form of heterosporous strobili. Whether or not such was the case with all the Lepidostrobi, we are yet unable to determine; but the incalculable myriads of their macrospores, seen in so many coals, afford clear evidence that the heterosporous types must have preponderated vastly over all others.

Gymnosperms. — Our knowledge of this part of the carboniferous vegetation has made great progress during the last thirty years. This progress began with my own discovery[2] that all our British Dadoxylons possessed what is termed a discoid pith, such as we see in the white jasmine, some of the American hickories, and several other plants. At the same time. I demonstrated that most of our objects hitherto known as Artisias and Sternbergias were merely inorganic casts of these discoid medullary cavities. Further knowledge of this genus seems to suggest that it was not only the oldest of the true conifers in point of time, but also one of the lowest of the coniferous types.

Cycads. — The combined labors of Grand-Eury, Brongniart, and Renault, have revealed the unexpected predominance in some localities of a primitive but varied type of cycadean vegetation. Observers have long been familiar with certain seeds known as Trigonocarpons and Cardiocarpons, and with large leaves to which the name of Noeggerathia was given by Sternberg. All these seeds and leaves have been tossed from family to family at the caprice of different classifiers, but, in all cases, without much knowledge on which to base their determinations. The rich mass of material disinterred by M. Grand-Eury at St. Étienne, and studied by Brongniart and M. Renault, has thrown a flood of light upon some of these objects, which now prove to be primeval types of cycadean vegetation.

Mr. Peach's discovery of a specimen demonstrating that the Antholithes Pitcairniae[3] of Lindley and Hutton was not only, as these authors anticipated, 'the inflorescence of some plant,' but that its seeds were the well-known Cardiocarpons, was the first link in an important chain of new evidence. Then followed the rich discoveries at St. Étienne, where a profusion of seeds, displaying wonderfully their internal organization, was brought to light by the energy of M. Grand-Eury; which seeds M. Brongniart soon pronounced to be cycadean. At the same time I was obtaining many similar seeds from Oldham and Burntisland, in which, also, the minute organiza-

[1] See Memoir xii., pl. xxxiv.

[2] E. g. L. Harcourtii, Memoir ix., pl. xlix., fig. 11.

[3] Memoir ix., pl. xxv., figs. 93, 94, 98, 99, 100, and 101.

[1] Memoir xi., pl. xlviii., fig. 4 *f f'*; Memoir ii., pl. xxix., fig. 42 *k*; Memoir iii., pl. xliii., fig. 17.

[2] On the structure and affinities of the plants hitherto known as Sternbergias. Memoirs of the literary and philosophical society of Manchester, 1851. M. Renault, in his Structure comparée de quelques tiges de la flore carbonifère, p. 285, has erroneously attributed this discovery to Mr. Dawes, including my illustration from the jasmine and juglans. Mr. Dawes' explanation was a very different one.

[3] Fossil flora. p. 82.

tion was preserved. Dawson, Newberry, and Lesquereux have also shown that many species of similar seeds, though with no traces of internal structure, occur in the coal-measures of North America.

Equally important was the further discovery by M. Grand-Eury, that the Antholithes, with their cardiocarpoid seeds, were but one form of the monoclinous catkin-like inflorescences of the Noeggerathiae, now better known by Unger's name of Cordaites. These investigations suggest some important conclusions. 1°. The vast number and variety of these cycadean seeds, as well as the enormous size of some of them, are remarkable, showing the existence of an abundant and important carboniferous vegetation, of most of which no trace has yet been discovered other than these isolated seeds. 2°. Most of the seeds exhibit the morphological peculiarity of having a large cavity (the 'cavité pollinique' of Brongniart) between the upper end of the nucelle and its investing episperm, and immediately below the micropile of the seed. That this cavity was destined to have the pollen-grains drawn into it, and be thus brought into direct connection with the apex of the nucelle, is shown by the various examples in which such grains are still found in that cavity.[1] 3°. M. Grand-Eury has shown that some of his forms of Cordaites possessed the discoid or Sternbergian pith which I had previously found in Dadoxylon. And, lastly, these Cordaites prove that a diclinous form of vegetation existed at this early period in the history of the flowering plants, but whether in a monoecious or a dioecious form we have as yet no means of determining. Their reproductive structures differ widely from the true cones borne by most cycads at the present day.

Conifers. — It has long been remarked that few real cones of conifers have hitherto been found in the carboniferous rocks, and I doubt if any such have yet been met with. Large quantities of the woody stems now known as Dadoxylons have been found, both in Europe and America. These stems present a true coniferous structure, both in the pith, medullary, sheath-wood, and bark.[2] The wood presents one very peculiar feature: its foliar bundles, though in most other respects exactly like those of ordinary conifers, are given off, not singly, but in pairs.[3] I have only found this arrangement of double foliar bundles in the Chinese gingko (Salisburia adiantifolia).[4] This fact is not unimportant when connected with another one. Sir Joseph Hooker long ago expressed his opinion that the well-known Trigonocarpons[5] of the coal-measures were the seeds of a conifer allied to this Salisburia. The abundance of the fragments of Dadoxylon, combined with the readiness with which cones and seeds are preserved in a fossil state, makes it probable that the fruits belonging to these woody stems would be so preserved; but of cones we find no trace, and, as we discover no other plant in the carboniferous strata to which the Trigonocarpons could with any probability have belonged, these facts afford grounds for associating them with the Dadoxylons. These combined reasons — viz., the structure of the stems with their characteristic foliar bundles, and the gingko-like character of the seeds — suggest the probability that these Dadoxylons, the earliest of known conifers, belonged to the Taxineae, the lowest of these coniferous types, and of which the living Salisburia may perhaps be regarded as the least advanced form.

Thus far our attention has been directed only to plants whose affinities have been ascertained with such a degree of probability as to make them available witnesses, so far as they go, when the question of vegetable evolution is *sub judice*. But there remain others, and probably equally important ones, respecting which we have yet much to learn. In most cases we have only met with detached portions of these plants, such as stems or reproductive structures, which we are unable to connect with their other organs. The minute tissues of these plants are preserved in an exquisite degree of perfection: hence we are able to affirm, that, whatever they may be, they differ widely from every type that we are acquainted with amongst living ones. The exogenous stems or branches from Oldham and Halifax which I described under the name of Astromyelon,[1] and of which a much fuller description will be found in my forthcoming Memoir xii., belong to a plant of this description. The remarkable conformation of its bark obviously indicates a plant of more or less aquatic habits, since it closely resembles those of Myriophyllum, Marsilea, and a number of other aquatic plants belonging to various classes. But its general features suggest nearer affinities to the latter genus than to any other. Another very characteristic stem is the Heterangium Grievii,[2] only found in any quantity at Burntisland, but of which we have recently obtained one or two small specimens at Halifax. This plant displays an abundant supply of primary, isolated, vascular bundles, surrounded by a very feeble development of secondary vascular tissue. Still more remarkable is the Lyginodendron Oldhamium,[3] a stem not uncommon at Oldham, and not unfrequently found at Halifax. Unlike the Heterangium, its primary vascular elements are feeble, but its tendency to develop secondary zylem is very characteristic of the plant. An equally peculiar feature is seen in the outermost layer of its cellular bark, which is penetrated by innumerable longitudinal laminae of prosenchymatous tissue, which is arranged in precisely the same way as is the hard bast in the lime and similar trees, affording another example of the introduction into the outer bark of the 'appareil de soutien.' As might have been anticipated from this addition to the bark, this plant attained arborescent dimensions, very large

[1] Memoir viii., pl. ii., figs. 70 and 72. Brongniart, Recherches sur les graines fossiles silicifiées, pl. xvi., figs. 1, 2; pl. xx., fig. 2.

[2] Dr. Dawson finds the discoid pith in one of the living Canadian conifers.

[3] Memoir viii., pl. lviii., fig. 48; and pl. ix., figs. 44–46.

[4] Memoir xii., pl. xxxiii., figs. 28, 29.

[5] Memoir viii., figs. 94–115.

[1] Memoir ix., in which I only described decorticated specimens. Messrs. Cash and Hick described a specimen in which the peculiar bark was preserved under the name of Astromyelon Williamsonis. See Proceedings of the Yorkshire polytechnic society, vol. vii. part iv., 1881.

[2] Memoir iii. *Ibid.*

fragments of sandstone casts of the exterior surface of the bark[1] being very abundant in most of the leading English coal-fields. Corda also figured it[2] from Radnitz, confounding it, however, with his lepidodendroid Sagenaria fusiformis, with which it has no true affinity. Of the smaller plants of which we know the structure, but not the systematic position, I may mention the beautiful little Kaloxylons.[3] We have also obtained a remarkable series of small spherical bodies, to which I have given the provisional generic name of Sporocarpon.[4] Their external wall is multicellular: hence they cannot be spores. Becoming filled with free cells, which display various stages of development as they advance to maturity, we may infer that they are reproductive structures. Dr. Dawson informs me that he has recently obtained some similar bodies, also containing cells, from the Devonian beds of North and South America. Except in calling attention to some slight resemblance existing between my objects and the sporangiocarps of Pilularia,[5] I have formed no opinion respecting their nature. Dr. Dawson has pointed out that his specimens, also, are suggestive of relations with the Rhizocarpae.

I am unwilling to close this address without making a brief reference to the bearing of our subject upon the question of evolution. Various attempts have been made to construct a genealogical tree of the vegetable kingdom. That the cryptogams and the gymnosperms made their appearance, and continued to flourish on this earth, long prior to the appearance of the monocotyledonous and dicotyledonous flowering plants, is, at all events, a conclusion justified by our present knowledge, so far as it goes. Every one of the supposed palms, aroids, and other monocotyledons, has now been ejected from the lists of carboniferous plants, and the Devonian rocks are equally devoid of them. The generic relations of the carboniferous vegetation to the higher flowering plants found in the newer strata have no light thrown upon them by these paleozoic forms. These latter do afford us a few plausible hints respecting some of their cryptogamic and gymnospermous descendants, and we know that the immediate ancestors of many of them flourished during the Devonian age; but here our knowledge practically ceases. Of their still older genealogies, scarcely any records remain. When the registries disappeared, not only had the grandest forms of cryptogamic life that ever lived attained their highest development, but even the yet more lordly gymnosperms had become a widely diffused and flourishing race. If there is any truth in the doctrine of evolution, and especially if long periods of time were necessary for a world-wide development of lower into higher races, a terrestrial vegetation must have existed during a vast succession of epochs, ere the noble lycopods began their prolonged career. Long prior to the carboniferous age they had not only made this beginning, but during that age they had diffused themselves over the entire earth. We find them equally in the old world and in the new. We discover them from amid the ice-clad rocks of Bear Island and Spitzbergen to Brazil and New South Wales. Unless we are prepared to concede that they were simultaneously developed at these remote centres, we must recognize the incalculable amount of time requisite to spread them thus from their birthplace, wherever that may have been, to the ends of the earth. Whatever may have been the case with the southern hemisphere, we have also clear evidence that in the northern one much of this wide distribution must have been accomplished prior to the Devonian age. What has become of this pre-Devonian flora? Some contend that the lower cellular forms of plant-life were not preserved, because their delicate tissues were incapable of preservation. But why should this be the case? Such plants are abundantly preserved in tertiary strata: why not equally in paleozoic ones? The explanation must surely be sought, not in their incapability of being preserved, but in the operation of other causes. But the carboniferous rocks throw another impediment in the way of constructors of these genealogical trees. Whilst carboniferous plants are found at hundreds of separate localities, widely distributed over the globe, the number of spots at which these plants are found displaying any internal structure is extremely few. It would be difficult to enumerate a score of such spots; yet each of those favored localities has revealed to us forms of plant-life of which the ordinary plant-bearing shales and sandstones of the same localities show no traces. It seems, therefore, that, whilst there was a general resemblance in the more conspicuous forms of carboniferous vegetation from the arctic circle to the extremities of the southern hemisphere, each locality had special forms that flourished in it either exclusively, or at least abundantly, whilst rare elsewhere. It would be easy, did time allow, to give many proofs of the truth of this statement. Our experiences at Oldham and Halifax, at Arran and Burntisland, at St. Étienne and Autun, tell us that such is the case. If these few spots which admit of being searched by the aid of the microscope have recently revealed so many hitherto unknown treasures, is it not fair to conclude that corresponding novelties would have been furnished by all the other plant-producing localities, if these plants had been preserved in a state capable of being similarly investigated? I have no doubt about this matter: hence I conclude that there is a vast variety of carboniferous plants of which we have as yet seen no traces, but every one of which must have played some part, however humble, in the development of the plant races of later ages. We can only hope that time will bring these now hidden witnesses into the hands of future paleontologists. Meanwhile, though far from wishing to check the construction of any legitimate hypothesis calculated to aid scientific inquiry, I would remind every too ambitious student that there is a haste that retards rather than promotes progress, that arouses opposition rather than produces conviction, and that injures the cause of science by discrediting its advocates.

[1] Memoir iv., pl. xxvii.
[2] Flora der vorvelt, tab. 6, fig. 4.
[3] Memoir vii.
[4] Memoirs ix., x.
[5] Memoir ix., p. 348.

LETTERS TO THE EDITOR.

Greenland geology.

IN the seventh volume of Heer's Flora fossilis arctica, just issued, my distinguished colleagues, Professor Heer of Zurich, and Herr K. F. V. Steenstrup of Copenhagen, seem to be at cross purposes with me, regarding the positions and Eskimo names of the localities where the collections of fossil plants discovered by us were obtained; Mr. Steenstrup giving the spot one name, and I another, while, owing to this misapprehension, the exact latitude of at least one place is differently entered in our respective papers. For instance: we apply the name of 'Kudlisact' (Kitludsat) to spots at considerable distances from each other, and do not quite understand the same place by the word 'Unartok.' Heer, who has, however, never been in Greenland, notes (p. 203) that "nach Steenstrup fällt Ujarasuksumitok von R. Brown (Flora foss. arct., ii. p. 452) mit Unartok zusammen und der Name beruht auf missverständniss." Again: Steenstrup, in the admirable memoir appended to Heer's work, mentions that "Brown zufolge *l. c.* [*Philosophical transactions*, 1869, p. 445, and *Transactions of the geological society of Glasgow*, vol. v. p. 36], war es hier [at Unartok], dass er und Whymper im jahr 1867 versteinerungen sammelten. Meines erachtens rüht der name Browns 'Uiarasuksumitok' von dem umstande her, dass der Grönlander ihn missverstanden und geglaubt hat, dass er gefragt würde, woher er (der Grönlander) wäre, worauf er eine antwort gab, die ungefähr bedeutet 'Ich bin aus Ujaragsugsuk'" (p. 247). I do not doubt for a moment that Mr. Steenstrup may be right; and his general accuracy forbids me to assert that he is wrong. My acquaintance with Danish was in 1867 (as it is still) trifling, while of Eskimo I was all but ignorant. And even with the greatest care, it is always difficult to arrive at the exact designation of localities in Greenland. However, Mr. Tegner, who accompanied us, was familiar with Eskimo, and of course, as a Dane, with Danish; and the names attached to my map and paper referred to were arrived at, after repeated cross-questioning of our native boatmen, and of Paulus, the intelligent Eskimo catechist at Ounartok (Unartok), who wrote them down in a note-book, at present before me. Curiously enough, in a note in the hand-writing of the late Chevalier Olrick, so many years governor of North Greenland, the place is called 'Ujarasaksumitok,' which naturally led me to believe that this was a synonyme of Ujaragsugsuk, under which name it is also designated by Dr. Rink, in my edition of Danish Greenland (p. 349). 'Ritenbenks Kolbroff' I regarded as the same place as Unartok, for there coal was being mined; while Steenstrup seems to consider it the same as Kudlisaet. The latter spot, after a series of very careful, and, I am certain, accurate, meridian altitudes, I place in Lat. 70° 5′ 35″ N., while Nares puts the Ritenbenk coal-mine, so called (Kudlisaet), in Lat. 70° 3′ 4″, which convinces me that this spot is what I took to be Unartok. At my Kudlisaet there was, in 1867, no coal being dug. Anyhow, in the 'Geological notes on the Noursoak Peninsula, Disco Island, etc.' (*Trans. geol. soc. Glasgow*, vol. v. p. 55), I have so fully described these localities, that no future explorer can mistake them. But as many may see Heer's work who may not be able to consult my humbler brochure, I ask permission to make these explanations in the columns of a scientific journal, which, as the mouthpiece of American geologists, takes cognizance of far-away Greenland also. Moreover, as one might suppose, from Mr. Steenstrup's (inadvertently, no doubt) mentioning that Nares and I differed two minutes and thirty-one seconds (2′ 31″) in our latitudes of 'Ritenbenks Kohlenbruch,' that there was some *inexcusable roughness* in the use of the sextant and artificial horizon, while in reality we observed *at two totally different places*, the matter is, though not of great scientific or geographical importance, in a manner personal to myself, if not to Sir George Nares.

ROBERT BROWN.

Streatham, London, Eng.,
Sept. 24, 1883.

Human proportion.

In a review of my lecture on 'Human proportion in art and anthropometry' (SCIENCE, ii. 354), the accuracy of certain statements contained therein is questioned. Permit me space for a brief reply.

The critic says that the implement in the hand of the Egyptian figure is a *crux ansata*, the symbol of eternity, and not 'a key.' But M. Charles Blanc, whose description I was quoting, says 'la personnage tient *une clef* de la main droite;' and the expression is warranted, as it is, in its symbolical sense, spoken of by Egyptologists as 'a key.'

His next assertion is, that the Doryphorus of Polykleitus was not, as I stated, 'a beautiful youth in the act of throwing a spear,' but a spear-bearer of the body-guard of the Persian king. The latter functionary, however, wore a long robe, termed the 'candys,' extending from the neck to the mid-leg, and could not have been selected for a model, which necessarily required a naked figure. Pliny (Hist. nat., xxxiv. 8) says, 'Idem et Doryphorum *viriliter puerum* fecit,' etc.; and many other allusions in classical writers confirm this view.

The last and most surprising criticism is the statement that my assertion that prior to the time of Phidias, the face, hands, feet, etc., were carved in marble, and were fastened to a wooden block, is "a complete misunderstanding of the nature of the archaic *ξόανα*, or wooden statues, which in Greece preceded those made of stone or metal." Now, the *ξόανον* was simply a wooden statue. (Cf. Pausanias, vii., 17, 2, *τοσάδε ἦν ἀφ' ὧν τὰ ξόανα*, etc.) It was succeeded by a more elaborate invention, known as an *acrolith*, from *ἄκρος* and *λίθος*, *stone-ends*. Pausanias describes one of them (ix. 4): "The statue of the goddess [the Plataean Athena of Phidias] is made of wood, and is gilt, except the face, and the ends of the hands and feet, which are of Pentelican stone." See also Quatremère de Quincy, Monuments et ouvrages d'art antiques, vol. ii., Restitution de la Minerve en or et ivoire de Phidias au Parthenon, pp. 63–123; also Müller, Handbuch d. archaeol. d. kunst, § 84. Dr. William Smith states the case concisely (Dict. Gr. and Rom. mythol., vol. iii. p. 250): "Up to his [Phidias's] time, colossal statues, when not of bronze, were *acroliths*; that is, only the face, hands, and feet were of marble, the body being of wood, which was concealed by real drapery." ROBERT FLETCHER.

Washington, Oct. 8, 1883.

[The most common of all the Egyptian symbols is an emblem in the form of 'a handled cross,' symbolical of 'life;' but both the nature of the object represented, and the reason of the symbolism, are equally unknown. To call it 'a key' is certainly wrong, as the Egyptians had none; and by archeologists it is usually designated by the conventional term '*crux ansata*.'

That the word 'Doryphoros,' *ex vi termini*, cannot mean 'a youth in the act of *throwing* a spear,' as Mr.

Fletcher says, but simply a 'spear-bearer,' is what our criticism was intended to convey.

Although it may be true enough that 'prior to the time of Phidias, *colossal* statues, when not of bronze, were *acroliths*, our criticism was directed to the author's broad assertion, which entirely ignored the existence of *ξόανα*.]

Writer of the notice of 'Human proportion.'

Geology of Philadelphia.

Will Professor Henry Carvill Lewis state where the term 'hydro-mica slate' is used by H. D. Rogers, or in that portion of the report on Chester county written by the undersigned?

The word occurs seven times in the Lancaster county report; but in every case except the italics on p. 10, which the reference on the ninth line below shows to be a misprint, it is used in the sense defined in my criticism, and not as an equivalent for hydro-mica-schist. As his defence of the use of the other terms alluded to does not meet the objections, no further remark is necessary.

Persifor Frazer.

Sept. 28, 1883.

The chinch-bug in New York.

We have the chinch-bug (Blissus leucopterus Say) in New York in formidable numbers. Its appearance with us is of great interest, as hitherto the only record of its occurrence is that of Dr. Fitch, who, several years ago, saw three individuals of it upon willows in the spring. I had never before met with it in our state. Dr. Harris, you will remember, mentions having seen one example in Massachusetts. By some manner it has been introduced here, and I can think of no way so probable as that it has been brought in a freight-car from the west.

The locality of its occurrence is in St. Lawrence county, the most western of our northern counties. As it was for some time thought that the insect could not live north of 40° of latitude, this seems a strange locality for its first appearance.

Its operations were first noticed in a field of timothy-grass last summer, but the depredator was not then discovered. This summer the infested area had largely extended, and, upon a more thorough search being made, it was found in myriads — could be scooped up, it is stated, by handfuls — among the roots of the living grass bordering the killed area. In the fields infested, the timothy, June, and 'wire grass' are completely killed, so that they are succeeded the following season by thistles, weeds, and patches of clover. So far, it has not attacked wheat or corn, of which, however, very little is grown in St. Lawrence county.

I have just visited the infested locality, and I find it to be a very serious attack. It is rapidly extending to other than the two farms upon which it was observed last year, and it in all probability exists in many places where it has not yet been detected. Great alarm is felt throughout the district invaded, as the timothy-grass is the foundation of the grazing interests of that region. Clover, owing to the severity of the winters, cannot be grown to any extent. The most threatening feature of the attack is, that it has continued to increase, notwithstanding that this year and the preceding have both been unusually wet in northern New York. Garden-crops were killed by the heavy and continued rains; grass is lying in the meadows, which could not be secured; and so cold has the season been, that fields of oats are still unharvested. All writers have concurred in stating that the chinch-bug could not endure cold and wet seasons, and that heavy rains were invariably fatal to it. It really seems as if the new-comer was destined to be a permanent institution in the state.

The farmers are aroused to the importance of doing what they can to arrest and repel the invasion. I have recommended that it be fought with that valuable insecticide, kerosene-oil, emulsified and diluted; and, if generally used the ensuing spring, I have great faith in its proving efficient.

J. A. Lintner.

Office of the state entomologist
Albany, Oct. 9, 1883.

Ziphius on the New-Jersey coast.

A telegram was received at the Smithsonian institution on the 3d inst. from the keeper of the life-saving station at Barnegat City, N.J., announcing the stranding of a large cetaceau at that place. Professor Baird immediately despatched the writer and a preparator from the museum to take charge of the specimen. On arriving at Barnegat City, I immediately perceived that we had to do with an example of an aged female of an interesting ziphioid whale; and, when the skull was cut out, it became evident that the animal was of the genus Ziphius. The specimen measures 19 feet 4 inches in length, and was apparently of a light stone-gray color, darkest on the belly. This disposition of color is unusual in cetaceans. The species is probably Z. cavisortris.

Mr. Palmer and myself succeeded in making a plaster mould of half the exterior, and in cutting out the complete skeleton.

The genus Ziphius has not, I believe, been hitherto recorded as occurring in the north-western Atlantic.

Frederick W. True,
Curator of mammals.

U. S. national museum,
Oct. 11, 1883.

THE DE LONG RECORDS.[1]

The voyage of the Jeannette. The ship and ice journals of George W. De Long, Lieut.-commander U.S.N., and commander of the polar expedition of 1879-81. Edited by his wife, Emma [Jane Wotton] De Long. 2 vols. Boston, *Houghton, Mifflin, & Co.*, 1883. 12+911 p., illustr. 8°.

The voyage of the Jeannette, owing to its connection with a great newspaper, has become, in its general features, familiar to all. The courage, endurance, and patience with which the members of the party met pain, peril, privation, and even death, will always remain a conspicuous example of manly quality. This expedition, however, was unique in several of its features, which should be taken into account in any judgment rendered upon its results. It was not an expedition for scientific research in the arctic regions. It was not scientifically planned. It had, so far as can be learned from the documents, no programme. Of its members, but two, a civilian and a seaman, had had any experience of an arctic winter; none had made any serious study of the physical conditions of the polar area; and, without

[1] For the woodcuts illustrating this article, the editor is indebted to the publishers of the work, Messrs. Houghton, Mifflin, & Co.

disrespect, it may be said, that, with the possible exception of two civilians, there was no one on board whose scientific acquirements rose above the daily needs of the intelligent practice of his profession. The object of the expedition, as far as may be surmised from the circumstances made public, seems to have been to determine what would be the result of a set-to between the arctic pack, cold and starvation on the one hand, and a shipful of inexperience and 'pure grit' on the other. The result is now known; and the innocent confidence with which both promoter and explorer undertook the task is one of the extraordinary features of this melancholy history. Under the circumstances, it is well that Mrs. De Long has made public her husband's records of the story, already twice told elsewhere. The account of the voyage is preceded by some details of the previous life of De Long, who, from an early age, showed evidence of great force of will and audacity, and who preserved until his death the religious convictions instilled by a fond and pious mother. There seems to have been no special turn for study in the lad, whose energy, nevertheless, carried him through the Naval academy with credit. The introduction to that friendship with Mr. Bennett which finally led to De Long's selection as commander of the arctic expedition, is left untold. It is evident that these two had a strong and well-founded friendship, and perfect mutual confidence. The voyage once determined upon, Mr. Bennett providing the vessel and the means, the government lending its naval organization and prestige, De Long had only to choose his party, and organize his plans. The first was soon, and, all must admit, remarkably well done. Certainly, no body of men ever stood harder test of fidelity to their commander than that little party, and with less flinching.

The vessel, it is now generally admitted, was tolerably well adapted to her purpose, and endured from the ice all that could be expected in like circumstances. The provisions, on the whole, turned out well; and the equipment, in the course of the expedition, showed no serious deficiencies. On the whole, then, well provided, and with much popular approbation and sympathy, the expedition departed on the 8th of July, 1879, from San Francisco. A *rendezvous* was had Aug. 2, at Unalaska, — that cosey little harbor which has received so many expeditions, and bravely borne up the barks of Kotzebue, of Lütke, of Levasheff, of Kruzenstern, of Sarycheff, and many more masters of exploration. Ten days afterward they anchored at St. Michael's, Norton Sound. Here dogs, furs, and coal were shipped; and then the Asiatic coast of Bering Strait was reached, and some time spent in endeavoring to determine the fate of Nordenskiöld. Here several

UNALASKA.

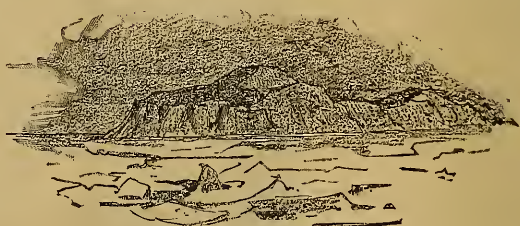
curious bone implements were collected, which are figured, but not referred to in the text. One of these we reproduce.

Pushing into the Arctic on Sept. 6, the vessel was beset in the pack north-eastward of Herald Island. From its rigid embrace she was never released, except to sink, a shattered wreck, beneath its surface, nearly two years later.

On Jan. 19, 1880, she received a wrench from an under-running tongue of ice, creating a leak, which remained a more or less constant source of anxiety. From this time until the 16th of May, 1881, the time passed uneventfully; the ship fast in the ice, which occasionally groaned, shrieked, crunched, or thundered, with the various motions imparted to it by wind and tide, threatening instant destruction to ship and party. A few bear and seal hunts, ordinary

BONE SHOVEL.

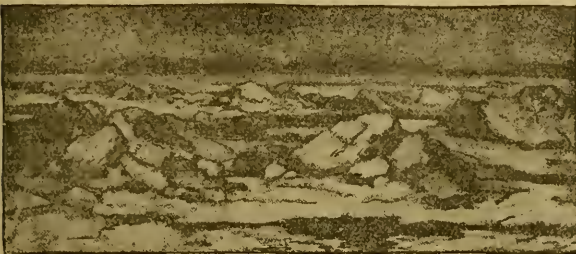
meteorological observations, the quarrels of the Eskimo dogs, innumerable devices for saving coal, pumping the ship dry, or preventing condensation of moisture within the living-rooms,—these things, and such as these, made up the characteristics of a life which eventually became almost unendurable in its monotony. Good health in general prevailed, owing to the extraordinary precautions planned by Dr. Ambler, and energetically put in force by the commander. No extreme temperatures (rated by the experience of other arctic voyages) were noted: indeed, the mildness, arctically speaking, of the temperatures experienced, is somewhat remarkable. The auroras do not seem to have been sufficiently brilliant to call for especial comment. The ice reached about six feet in thickness, and all parts of it contained more or less salt; while the precipitation of snow was insufficient to afford a supply of drinking-water by melting. On this account, water had to be distilled most of the time,—a process which used much invaluable fuel. Many of their experiences were such as had already been recorded by those who drifted with the Germania's crew, the Tegethoff, or the floating Polaris' party, of which the indefatigable Nindeman had been a member. Payer's conclusion that the motions of the arctic pack result from the friction upon its surface of the prevailing winds, was fully confirmed, and placed upon an impregnable basis, by the drift of the Jeannette. This is perhaps the most important generalization the history of the voyage affords. Another fact of value is the determination of the shallow character of this part of the arctic basin, which nowhere reached one hundred fathoms in depth, and was usually less than fifty fathoms. From the constant though moderate motion of the pack which held the vessel, tidal observations were impracticable; and the disturbances of the surface so occasioned, also prevented the permanent occupation of an observatory away from the ship. Polar bears, seals, a fox or two, walrus, and a small number of birds, comprise the air-breathing vertebrates obtained. Some fish-bones were found on the ice, but it does not appear that any fishing was attempted. Vignettes from the pencil of Mr. Newcomb, who acted as naturalist of the expedition, are scattered through the text, and illustrate the scanty fauna in a neat and artistic way. On the 16th of May, 1881, land was seen bearing nearly west, which was named Jeannette Island. It proved to be a small rocky island with bold shores, and was situated in latitude 76° 47′, and east longitude 158° 56′. On the 24th another island was observed more to the north and west, which



JEANNETTE ISLAND (FROM A SKETCH BY MR. MELVILLE).

A POLAR BEAR.

was named Henrietta Island. This was visited by Melville, with a small party, ten days later. After great difficulties, caused by the hummocky ice, they succeeded in landing upon it, and found it to be a desolate rock, surmounted by a snow-cap which discharged in several glaciers on the east side. Dovekies nesting on the face of the rock were the only sign of life about it other than a little stunted vegetation. But a great change was at hand. Motions and fractures of the ice increased; and the ship was evidently in serious danger, which was accordingly provided for. On June 12, 1881, the Jeannette yielded to the irresistible pressure, and at four o'clock the next morning she sank. The retreat was then organized and begun, with several men on the sick-list in addition to the usual difficulties offered by rough, broken, and fissured ice. After a little, De Long made the painful discovery that the ice was drifting northward faster than they were able to travel in a southerly direction. The course was therefore altered to cross the drift in a south-westerly direction, in the hope of escaping from the moving area. About the middle of July more land was observed, and on the 28th the party succeeded in landing upon it after almost incredible exertions. This land, the loom of which had been reported by Russian explorers on the New Siberian Islands many years ago, but which had never been definitely verified or charted, was named Bennett Island; and we observe that in the map accompanying the work, this and the others are very appropriately included under the name of the De Long Islands. Coal, hematite, fossiliferous limestone, clay, and lavas were observed on this island, and, more important for the party, myriads of sea-fowl breeding in the rocky cliffs. There were several glaciers, and, to one hundred feet above the sea, masses of drift-wood embedded in the soil, indicating tolerably recent elevation of the land. Hence by way of the New Siberian Islands, touching at Thaddeieff, Kotelnoi, Semeonoffski, the party made their way, but became separated in a gale of wind on the 12th of September, after which the smallest boat, with its crew, was never heard from; and finally the two remaining boats reached the shores of the Lena delta. De Long landed on the north Sept. 17, and Melville the previous day reached the south-eastern angle, and entered a branch of the river. It is not necessary to recapitulate the circumstances which attended the retreat, — the heroic journey of Nindeman and Noros, the indefatigable search of Melville, the final recovery of the remains, and their temporary interment on Monument Hill, looking out upon the flat stretches



BENNETT ISLAND AS SEEN IN THE DISTANCE, JULY 19.

MONUMENT HILL, LENA DELTA.

of the delta. These facts are the property of the public, which has not failed to appreciate the heroic qualities exhibited, nor to observe that the disastrous result of this unfortunate expedition offers in great part its own explanation. If it teach the aspiring that mere uninstructed courage cannot take the place of science, De Long and his people will not have died in vain. That this lesson should be especially emphasized, from recent events in another part of the arctic regions, will occur to most of our readers. Perhaps it would be well to permit future candidates for such work to convince themselves by trial, that the most exalted bravery will not enable the inexperienced to milk a fractious cow; and that, if so simple a matter requires knowledge and experience, it may be well to hesitate before assuming the fearful responsibility of hazarding the lives of even willing subordinates, without reasonable preparation for the problems offered by all serious arctic work, whether of exploration or retreat. Tenderness toward the dead should not be for an instant permitted to befog this self-evident truth, the statement of which is a duty owed, not merely to those who may hereafter attempt arctic exploration, but on behalf of scientific training everywhere.

STEP'S PLANT-LIFE.

Plant-life: popular papers on the phenomena of botany. By Edward Step. With 148 illustrations drawn by the author, and engraved by W. M. R. Quick. New York, *Holt & Co.*, 1883. 12+218 p. 12°.

Year by year there is what may be termed a noticeable amelioration in the character of the botanical literature which appears in this country. By this we mean no discourtesy to the authors of the many excellent works which have appeared from time to time. In certain scientific lines, the botanical literature of the United States has been both voluminous and of a high order of excellence. In systematic botany, the publications of Torrey, Gray, Eaton, and Watson (to mention only a few of the later workers) have not been excelled anywhere. We may justly feel a national pride in such magnificent books as the two volumes of the Botany of California, the Botany of the Clarence King reports and of the Wheeler reports, the Ferns of North America, etc. Then, too, our school and college books have been worthy of their authors. What country was ever supplied with better field-manuals than Gray's or Wood's? and where can one find as good a treatise on the morphology of the phanerogams as Dr. Gray has given us in the latest edition of his Structural botany?

All these, however, are for students and botanists proper. They were not designed for the general reader, — the man who does not take botany in such dreadful earnest as do the botanists, but who asks of the gentle science that it shall please and amuse him. Our scientific botanists have been too busy with the serious matter of instructing their classes of young people in school and college, to turn aside and furnish entertaining reading for the unbotanical. We can scarcely blame them for thus neglecting the great outside world, when the small world of the classroom required all their time and strength; and yet we cannot help feeling that it would have been better for the botanists, as well as for botany itself, had they compelled themselves to find time for those lighter works which have, in other countries, been at once the recreation of the scientific man and the pleasure of the general reader.

In the work before us we have an example of what may be done in the way of putting the main facts of biological botany before the unbotanical in plain and easy English, and in such a way as to be attractive and interesting. We wish its English author were an American; but, that being an impossibility, it is most gratifying that the Messrs. Holt have brought out so neat an American edition.

It is, of course, to be expected that there is nothing new botanically in such a book; so that those who are fairly well equipped with a knowledge of recent botanical literature need not take it up in the hope of gleaning any new facts. It is only what its titlepage indicates, — an aggregation of popular papers on some of the phenomena of botany. They are not profound, nor are they so arranged as to present themselves as a series of connected lessons. They are rather like lightly drawn sketches, — now of this interesting view of a portion of the plant-world, and now of that. Thus we have a chapter on microscopic plants, another on plant structure and growth, one on the fertilization of flowers, followed by others on predatory plants, remarkable flowers and leaves, and about a fern. Then we have the folk-lore of plants, plants and animals, mosses and lichens, etc. So the chapters (fourteen in all) run on through the book, there being a delightful alternation of the structural with those which deal with sentimental or poetical considerations.

Considering the nature of the book, the errors are remarkably few. Here and there, however, are statements which ought to be changed in a second edition. The Zygnemae are erroneously described as producing zoospores (p. 5), — a statement true enough of their relatives the Confervae, but not of any of the Zygnemae. Of roots it is said positively (in italics, p. 29) that 'they are never green,' which, to say the least, is a strong statement. On p. 34 we find that "in some plants the calyx or corolla is entirely wanting, in which case the floral covering is called the *perianth*," which is certainly not in accordance with ordinary usage. On the same page the stigma is curiously described as 'the surface of the style.' The Equiseta are not leafless, as they are said to be on p. 164. Their leaves are small, it is true; but certainly the whorls of united leaves at each joint are evident enough to even the casual observer. The formation of the zygospore in Mucor is not correctly given on p. 184, where it is described as resulting from the union of two aerial hyphae. On p. 192, in describing the fly fungus, the reader is given the impression that a mycelium upon a surface (as a window-pane) attacks its hapless victim, the fly, which, when dead, is said to be "standing upon a mat of delicate silk threads spread upon the glass."

Fig. 21 (repeated in fig. 143) is erroneous in showing the hyphae of the potato fungus to be septated. Fig. 104 is said to show the antheridia of a moss; but certainly no such organs are visible in the cut given.

In spite of the slips noted above, and others which we may well pass over, the little book is a pleasant one to read, and we feel sure that it will receive a hearty welcome from plant-lovers everywhere.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Saturn's rings. — Encke's division in the outer ring of Saturn has been examined by M. Schiaparelli, who finds that the position and lack of symmetry are the same as previously noticed, but the line is broader, and more diffused than in 1881. He thinks the phenomenon is variable, and accounts for it by supposing the middle of the ring to be thinner, and by the change of orbit of the particles composing it. He also examined carefully the region about the inner bright ring and the dark ring. At times O. Struve's division was seen very distinctly, and on other occasions very faintly. More observations are necessary to determine whether the phenomenon is variable. — (*Observ.*, Aug.; *Astr. nachr.*, 2,521.) M. McN. [289

The great comet of 1882. — Mr. Maxwell Hall shows the possible identity of the great comet of 1882, the comets of 1880, 1843, and 1668, with a comet which appeared B.C. 370, and which was said to have separated into two parts. The orbits of all are nearly identical. Taking a period not greatly different from that given by Prof. Frisby for the comet of 1882, he identifies the comets of B.C. 370 and A.D. 1843 with one which was seen in 1106. No comet is recorded for A.D. 368. The comets of 1880 and 1882 may possibly be identical with two which appeared in 1131 and 1132, and with the second part of the comet of B.C. 370. If this is the case, this comet also probably separated into two parts at its unrecorded appearance in A.D. 381 or 382. We already have an instance of this separation in Biela's comet; and the comet of 1882 gave evidence, to a certain extent, that a process of disintegration was going on. — (*Observ.*, Aug.) M. McN. [290

PHYSICS.

Electricity.

Atmospheric electricity. — Dr. L. J. Blake has found that no convection of electricity takes place by the rising vapor from a charged liquid surface, to which he gave a potential due to from four to five hundred Daniells cells. The plate placed in the track of the vapors was, in the different experiments, either colder than the vapor, or of the same temperature. By connecting the liquid with the electrometer, he finds a small negative charge, increasing during the fifteen minutes which each experiment lasted, but not sufficiently to justify the statement that electricity is generated by evaporation. In all the work, the lamp was removed before connecting with the electrometer; and the whole apparatus was within a metallic covering connected with the earth. Distilled water, sea-water from the North Sea, alcohol, dilute sulphuric acid, mercury, and solutions of a number of different salts, were tried. — (*Ann. phys. chem.*, xix. 518.) [291

ENGINEERING.

A new current-meter. — Mr. L. d'Auria proposes an apparatus for determining the mean velocity at any vertical in a stream, which apparatus consists of a scow, or pontoon, to be moored in the desired place; a pole with a pulley near each end, carrying an endless cord; a light ball; and a species of net, or grillage. The pole is thrust to the bottom alongside the scow, at the point where the velocity is to be gauged; and the ball is lightly attached to the cord by a string, so as to be disengaged by a moderate pull when it reaches the pulley at the bottom. The time of the disengaging pull is noted, and also the time of the appearance of the ball at the surface. As the floating grillage has previously been moored over this place, the ball is caught at the point of rising, and the horizontal distance of this point from the pole measured. Hence are known, upon measuring the depth, the two co-ordinates of the point at the surface from the bottom of the pole. The author proposes to weight the ball until it shall be one-half the heaviness of water. He deduces some equations to prove that the ball rises with a practically uniform velocity, and observes, that for a depth of 30 feet, from which such a ball would rise in about 11 seconds, and a mean velocity of current of 4 feet per second, the ball would travel horizontally about 44 feet.—(*Amer. eng.*, Aug. 24.) C. E. G. [292

CHEMISTRY.

(Physical.)

Determination of vapor density.—Br. Pawlewsky proposes a modification of Dumas' method in which he uses a globe of 20–30 cubic centimetres volume. After heating, the globe is closed by a rubber cap, which is fitted to a cylindrical tube of glass sealed at one end. The volume is therefore constant for different determinations, and the observations may be taken in a room of nearly constant temperature. In the formula of Dumas,—

$$m = \frac{0.0012932 \,.\, V \,.\, B_0}{(1 + a t)\ 760}, \qquad \text{(I.)}$$

where m is equal to the weight of air, the product $0.0012932 \,.\, V = K$ would be constant. The value $(1 + a t) = N$ is constant, and may be obtained from a table. If, then, the constant, K, is divided by 760, a new constant, D, results, and (I.) becomes

$$m = \frac{K \,.\, B_0}{N \,.\, 760} = \frac{D \,.\, B_0}{N}. \qquad \text{(II.)}$$

In a determination at any temperature, t'_0, and any pressure, B'_0, if the weight of air in the apparatus is represented by n, its weight is shown in the formula

$$n = \frac{0.0012932\ V\ (1 + \kappa t')\ B'_0}{(1 + a t)\ 760}, \qquad \text{(III.)}$$

in which κ represents the coefficient of expansion of the apparatus. If the temperature is constant, and the same apparatus is used in different determinations, the product $0.0012932\ V\ (1 + \kappa\, t')$, and the whole denominator, become constant. Representing the denominator by R, and the product $0.0012932\ V\ (1 + \kappa t')$ by M, the fraction $\frac{M}{R} = C$ is constant, and formula (III.) will take the form

$$n = \frac{M B'_0}{R} = C \,.\, B'_0. \qquad \text{(IV.)}$$

The volume of air may therefore be obtained by multiplying the constant, C, by B' reduced to B'_0; and when the weight, a, of the vapor, and that of the air, n, under the same conditions, are known, the vapor density may be found by the formula

$$D = \frac{a}{n}. \qquad \text{(V.)}$$

The apparatus may be heated in a beaker of medium size, containing water, oil, or paraffine. For a complete description of the apparatus, reference must be made to the original article. A series of determinations are given, which indicate a high degree of accuracy.—(*Berichte deutsch. chem. gesellsch.*, xvi. 1293.) C. F. M. [293

GEOLOGY.

Evidences of modern geological changes in Alaska.—Mr. T. Meehan exhibited a piece of wood taken from a prostrate tree which had been covered with glacial drift on a peninsula of Hood's Bay, Alaska, formed by the junction of Glacier Bay and Lynn Channel. The trunk, which lay under a block of granite estimated to measure 2,214 cubic feet, was quite sound, and exhibited no evidence of great age since it became covered. The shores are strewn with rocks and stones of various kinds, as usual in cases of glacial deposits. All the surroundings indicated that there had been a sudden subsidence of the land, accompanied by a flow of water with icebergs and huge bowlders, which crushed and tore off the trees. The whole surface was afterwards covered to a great depth with drift. Since that time, there must have been an elevation of the land bringing the remains of trees to their original surface, but with a deep deposit above them. A study of the existing vegetation might afford an approximation to the time when these events occurred. The living forest indicated clearly that it could not have been, at the farthest, more than a few hundred years since the elevation occurred. The trees in the immediate vicinity, indeed, were not more than fifty years old; but unless the original parent trees, which furnished the seed for the uplifted land, were near by, it might take some years for the seed to scatter from bearing trees, grow to maturity, again seed, and, in this way, be spread to where we now find them. But, as original forests were evidently not far distant, two or three hundred years ought to cover all the time required. The Indians of the region have a tradition of a terrible flood about seven or eight generations ago, from which only a few of the natives had escaped in a large canoe. The probable identity of the sunken trees with the present species, and the freshness of the wood, indicate no very great date backwards at which the original subsidence occurred.

In connection with the subject of the comparatively recent occurrence of great geological changes, as indicated by botanical evidence, Mr. Meehan referred to an exposure of the remains of a large forest near the Muir glacier,—one of five huge ice-fields which form the head of Glacier Bay between Lat. 59° and 60°. This glacier is at least two miles wide at the mouth, and has an average depth of ice, at this spot, of perhaps five hundred feet. At the present time there is not a vestige of arboreal vegetation to be seen in the neighborhood. The river which flows under the glacier rushes out in a mighty torrent a few miles above the mouth, and has cut its way through mountains of drift, the gorge being many hundred feet in width, and the sides from two hundred to five hundred feet high. The torrent, though the bed is now comparatively level, carries with it an immense quantity of heavy stones, some of which must have contained six or eight cubic feet. Along the sides of this gorge were the exposed trunks referred to, all standing perfectly erect, and cut off at about the same level. Some were but a few feet high, and others as much as fifteen, the difference arising from the slope of the ground on which the trees grew. The trunks were of mature trees in the main, and were evidently Abies Sitkensis, with a few of either Thuja gigantea or Juniperus, perhaps J. occidentalis. These trees must have been filled in tightly by drift to a height of fifteen feet before being cut off: otherwise the trunks now standing would have been split down on the side opposite to that which received the blow. The facts seemed to indicate that the many feet of drift which had buried part of the trees in the first instance were the work of a single season, and that the subsequent total destruction of every vestige of these great forests was the work of another one, soon following. As in the case of the facts noted in Hood's Bay, the conclusion was justified, that the total destruction of the forests, the covering of their site by hundreds of feet of drift, and the subsequent exposal of their remains, were all the work of a few hundred years. — (*Acad. nat. sc. Philad.; meeting* Aug. 28.) [294

MINERALOGY.

Stibnite from Japan. — Within the last few months most remarkable specimens of stibnite from Mount Kosang, in southern Japan, have been received in America. For great size and beauty, as well as complexity of form, they rival all specimens of the same species from other localities, while the crystals have arrived at a degree of perfection rarely met with in metallic minerals. The crystals have been carefully studied and fully described by E. S. Dana. Their great complexity of form is of the highest scientific interest. There had previously been identified on stibnite forty-five crystal planes. Of these, thirty have been observed on the Japanese crystals, and, in addition, forty new ones. The habit of the crystals is quite constant, being prismatic, elongated in the direction of the vertical axis, single crystals obtaining often a length of over twenty inches and a width of two inches. The prismatic planes are deeply striated. The crystals are usually terminated by a few polished pyramidal faces. They are usually quite simple in form; very complicated, large crystals occurring only occasionally, while the more complicated ones are usually small. The planes in the zone between the brachypinacoid (010) and unit macrodome (101) are those which ordinarily terminate the crystal. Another remarkable zone is between the brachypinacoid (010) and macrodome (203), consisting of ten planes, all but one of which are new, and as many as nine of which have been observed on a single crystal. A bending in the direction of the macrodiagonal axis is a feature of the crystals, and seems to be characteristic of the species. In the Japanese crystals this bending seems to be confined to the termination. A corkscrew-like twist has been observed in slender crystals. The lustre of the crystals is very remarkable, and is to be compared to highly polished steel, while the perfect brachypinacoidal cleavage yields a cleavage-surface of remarkable beauty. — (*Amer. journ. sc.*, Sept., 1883.) S. L. P. [295

GEOGRAPHY.

(*Asia.*)

Railways in the Caspian region. — General Chernaieff, the governor of Turkestan, has recently gone over the route from Kungrad to the Caspian in person, and finds it well suited for vehicles. Even a railway between the delta of the Oxus and the Gulf Mertvi-kuttuk has been talked of. The connection of Tiflis and Baku by rail is completed, and the journey can now be made between the Black and Caspian seas in thirty hours without change. — (*Comptes rendus soc. géogr.*, June.) W. H. D. [296

Prjevalski's travels. — This indefatigable explorer has just started for Kiachta, on the Siberian border of China, in order to continue his researches in central Asia. On this occasion he will endeavor to penetrate the north-west part of Thibet, without giving up his original idea of reaching Lassa, or at least as far as Batang or Tziamdo. He will have a well-armed escort of some twenty men, fully equipped for two years' service. The publication of the third volume of his travels has just been finished. During these he has travelled 23,530 kilometres; topographically sketched over 12,000 kilometres along his line of travel, in countries previously quite unknown; determined the altitude of 212 points, and the latitude of 48 localities; and has collected ten or twelve thousand specimens of animals and plants belonging to over two thousand species. — (*Comptes rendus soc. géogr.*, June.) W. H. D. [297

(*Africa.*)

Notes. — C. Doelter has ascended the Rio Grande as far as Futa Djallun, but was prevented from going farther east by a war among the natives. He believes that the Rio Grande has been incorrectly mapped, and doubts its alleged identity with the Tomani River. —— The English have annexed the Guinea coast from the right bank of the Mannah River toward the Liberian boundary-line, — a distance of eight leagues in a north-westerly direction; and the Portuguese government has ceded to England the fort of St. John de Ajuda, situated on the Dahomey coast. Ajuda, or Whydah, is situated a short distance from the coast, on a shallow lagoon. The port is a poor one, like all those on the Guinea coast; and there are very few white residents. It is said that the cession was contingent on the recognition, by England, of the acquired rights of Portugal on the Congo. —— Robert Flegel, during the past season, has discovered the source of the Binué, an affluent from the east of the lower Niger, and also of the Logné, which discharges into Lake Chad. In this way he has been able to trace the watershed between the two basins, through a previously unexplored district. —— Hore has arrived at Ujiji on Lake Tanganyika, and proposes to establish a regular postal service on the lake, between the missionary and other stations. —— Dr. Baxter has attempted an exploration of the country of the Massai adjacent to Mpuapua.

These people are extremely hostile to strangers, and his success, therefore, is problematical. —— The Mahdi, or false prophet, who has been menacing Khartum, is reported to have captured the traveller, G. Roth, who was sent out by the Geographical society of St. Gall, Switzerland, to explore the upper Nile. —— Yunker has succeeded in passing from the basin of the Nile to that of the Congo, and continues his explorations, while one of his party has returned with the collections made in the Niam-Niam country. —— Paul Soleillet writes from Ankober of his safe arrival at Shoa, the success of his journey, and his favorable reception by King Menelik II., who governs all the population of Obok Shaffa and adjacent region with a firm rule. Menelik is favorable to trade with foreigners; and it is announced that he has been named by King John of Abyssinia as his successor, in default of direct heirs, to that kingdom. Soleillet has formed valuable collections, and has discovered wild coffee forming a dense undergrowth in the forest along the river Guébé, and indefinitely beyond. He reports the product of the wild plant to be of excellent quality. —— The abbé Trihidez, almoner of the army of occupation in Tunis, is reported to have discovered at Susa some Phoenician stelae engraved in a rather artistic manner, and in a good state of preservation. These records have been pronounced to be of great interest by such eminent specialists as Renan and Berger. —— M. Alphonse Aubry has forwarded to the Ministry of public instruction at Paris, reports on the geology of the English colony of Aden, which is situated in the horseshoe-shaped crater of an extinct volcano, and on the French colony of Obok on the opposite shore of the Gulf of Aden. —— Gold has been found on the Kaap River in the Transvaal. Nuggets of half a pound in weight are reported. —— Oil has been 'struck' in Natal, near Dundee, and also large deposits of magnetic iron. A company has been formed at Pietermaritzberg to investigate these minerals. — W. H. D. [298

BOTANY.

Thermotropism. — Julius Wortmann has recently shown that radiant heat falling upon a growing organ can cause curvatures either toward or away from the source of energy, and that the phenomena are in general much like those produced by light. His experiments are interesting, but are, as yet, incomplete, leaving some questions which seem to us very important wholly unanswered. It is pretty clear, however, that hereafter we must add the words 'positive thermotropism' and 'negative thermotropism' to the already long list of new terms. — (*Bot. zeit.*, 1883, no. 29.) G. L. G. [299

On the growth of the epicotyl of Phaseolus multiflorus. — In a series of experiments published in 1878, Wiesner detected two maxima of growth characterizing the younger internodes of many plants, whereas Sachs (and more lately Wortmann) had recognized only one maximum. To satisfy himself of the correctness of his former observations, Wiesner has repeated and extended the experiments. His results, derived from more than one hundred cases, show that in the plant named there are two distinct maxima of growth. The measurements were made with Grisebach's auxanometer. — (*Bot. zeit.*, 1883, no. 27.) G. L. G. [300

VERTEBRATES.

Reptiles.

Organ of Jacobson in Ophidia. — Born regarded the cellular columns which form the greater part of the thickness of the roof of Jacobson's organ as "*die zellige ausfüllungsmasse einfacher drüsen von birnförmiger configuration. Sie dicht an einander gedrängt die ganze schleimhaut durchsetzen,*" while Leydig believed them to be largely of ganglionic nature. E. Ramsay Wright agrees with Leydig. He has studied the organ in Eutaenia (embryo and adult). In conclusion, he says, "From the above data I conclude that the cellular columns in the roof of Jacobson's organ are outgrowths of the nuclear stratum of its neuro-epithelium, the polygonal form of which has been determined by the meshes of the capillary plexus, through which the outgrowths have taken place, and that in the course of development more and more of the cells of the nuclear stratum have been pushed outside the boundary formed by the capillary plexus, till eventually little but the superficial stratum is left inside that boundary." — (*Zool. anz.*, vi. 389.) C. S. M. [301

Mammals.

The species of hogs. — M. Forsyth Major is convinced, from his study of the genus Sus, that the sixteen or seventeen species now recognized must be reduced to four; namely, Sus vittatus Müll. and Schleg., S. verrucosus M. and S., S. barbatus M. and S., and S. scrofa Linné. — (*Zool. anz.*, vi. (140), 1883, 295.) F. W. T. [302

Digestion of meats and milk. — Jessen has carried out a series of experiments to determine the time necessary for the digestion of equal quantities of different meats and of milk. Three different methods were employed in the investigation: 1. Artificial digestion; 2. Introduction of the meats into the stomach of a living dog by means of a fistula; 3. Upon a healthy man, allowing him to swallow the foods used, and ascertaining the time of digestion by means of the stomach-pump. The results obtained by the different methods are, on the whole, uniform, as far as the relative time necessary for digestion in each case is concerned, and may be stated as follows: raw beef and mutton are digested most quickly; for half-boiled beef and raw veal, a longer time is necessary; thoroughly boiled and half-roasted beef, raw pork, and sour cow's-milk follow next; fresh cow's milk, skimmed milk, and goat's milk are still less easily digested; while the longest time is required for thoroughly roasted meats and boiled milk. — (*Zeitsch. f. biol.*, xix. 129.) W. H. H. [303

ANTHROPOLOGY.

Iron in the mounds. — F. W. Putnam has had occasion to review some of the statements of the older writers on American archeology, — notably, Mr.

Atwater and Dr. Hildreth, — with reference to the occurrence of iron implements in the mounds. From these statements, such inferences as the following have been drawn: —

The mound-builders understood working iron; they had intercourse with civilized peoples; the mounds were built since the arrival of the whites, or these iron objects belong to intrusive burials. Now, Mr. Putnam demolishes all these deductions at a single blow, by showing that none of the objects are iron. In other words, Mr. Atwater's "handle of either a small sword or a large knife" was an antler, in one end of which a hole had been bored, and around this part was a band of silver. The blade was evidently of native, cold-hammered copper. Dr. Hildreth's silver-plated ear-ornament is duplicated in some of our museums by a kind of plating, first described by Mr. Putnam. In this discussion, some light is thrown upon the spool-shaped copper objects that have been so long a puzzle to archeologists, by the finding of pieces of 'leather' between the plates, very closely resembling the skin from the ear of a Peruvian mummy. Important discoveries made during the last year, in mounds in Ohio, by Dr. C. L. Metz and Mr. Putnam, have brought to light a number of copper ornaments, some of which are covered, or plated, with thin layers of silver. The investigation shows us quite conclusively that we are no longer safe in our archeological deductions, except in the hands of a skilful guide. — (*Proc. Amer. antiq. soc.*, ii. 349.) O. T. M. [304

Aztec music. — Mr. H. T. Cresson has been studying the musical instruments of the ancient Mexicans. The *huehuetl*, or large drum of the great temple, at the ancient pueblo of Tenochtitlan, was covered with the skins of serpents, and when beaten could be heard at a distance of several miles. Clay balls were placed inside of their grotesque clay images, also within the handles attached to their earthenware vessels, which are generally hollow. Some of these rattles in the Poinsett collection resemble the head of Crotalus horridus, and give forth a rattling sound. In this connection Mr. Cresson makes a very suggestive observation which we do not remember to have seen before: "It may therefore be supposed that these children of nature noticed and strove to reproduce sounds, which, however harsh and unmusical to us, to them were pleasing, because they recalled familiar objects." The author thinks he can recognize the Mexican Hyladae, macaws, parrots, and other bird-calls. A musical vase is spoken of. Mr. Barber's assertion that the fourth and seventh are wanting from the diatonic scale is denied, since, in the Poinsett collection, there exist Aztec flageolets capable of producing not only the fourth and seventh of the diatonic scale, but also the entire chromatic scale. This subject is elaborated at great length. Mr. Cresson thinks that the musicians of our day have arrived at a somewhat hasty decision in regard to the music of these ancient people, and its confinement within the narrow limits of a pentatonic scale. — (*Proc. acad. nat. sc. Philad.*, 86.) J. W. P. [305

NOTES AND NEWS.

The resolution of the American association, offering all the privileges of membership for next year's meeting to the members of the British association, was received by the latter with much enthusiasm; and the council of the British association, with which such matters lie, will, it is said, extend a similar invitation to the American association. The Canadian authorities have arranged for such members of the British association as may desire, to take the longer excursions planned for them *before* their meeting on Aug. 27, and thus allow them to attend the meeting of the American association in Philadelphia, Sept. 3, without losing their excursions. It is hoped that at least five hundred members of the British association, including many leading scientific men, will attend the Montreal meeting; while there seems to be a very general wish, more especially on the part of the younger scientific men, to attend the Philadelphia meeting as well.

— The following is the list of grants of money, which, according to *Nature*, the British association has granted for scientific purposes for the coming year; amounting, in all, to seven thousand dollars. When may we hope for even the beginning of such a list from the American association, with its two thousand members?

A. — Mathematics and physics.

Brown, Prof. Crum, Meteorological observations on Ben Nevis	£50
Foster, Prof. G. Carey, Electrical standards	50
Schuster, Prof., Meteoric dust	20
Abney, Capt., Standard of white light	20
Scott, Mr. R. H., Synoptic charts of the Indian Ocean	50
Stewart, Prof. Balfour, Meteorological observatory near Chepstow	25
Shoolbred, Mr. J. N., Reduction of tidal observations	10
Darwin, Prof. G. H., Harmonic analysis of tidal observations	45

B. — Chemistry.

Odling, Prof., Photographing the ultra-violet spark spectra	10

C. — Geology.

Etheridge, Mr. R., Earthquake phenomena of Japan	75
Williamson, Prof. W. C., Fossil plants of Halifax	15
Sorby, Dr. H. C., British fossil polyzoa	10
Prestwich, Prof., Erratic blocks	10
Etheridge, Mr. R., Fossil Phyllopoda of the paleozoic rocks	15
Hull, Prof. E., Circulation of underground waters	15
Evans, Dr. J., Geological record	15
Green, Prof. A. H., Raygill fissure	15
Prestwich, Prof., International geological map of Europe	20

D. — Biology.

Newton, Prof., Zoölogical bibliography . . £50
Sclater, P. L., Natural history of Timor Laut . 50
Lankester, Prof. Ray, Table at the zoölogical station at Naples 80
Harrison, J. Park, Facial characteristics of races in the British Isles 10
Hooker, Sir J., Exploring Kilimandjaro and the adjoining mountains of equatorial Africa . 500
Cordeaux, Mr. J., Migration of birds 20
Foster, Dr. M., Coagulation of the blood . . 50
Stainton, Mr. H. T., Record of zoölogical literature 100

E. — Geography.

Godwin-Austen, Lieut.-Col., Exploration of New Guinea 100

F. — Economic Science and Statistics.

Brabrook, Mr. E. W., Preparation of the final report of the anthropometric committee . 10

G. — Mechanics.

Bramwell, Sir F., Patent legislation 5

— Lieut. Ray returned to San Francisco, Oct. 7, by the schooner Leo. He left that port on July 18, 1881, under instructions from the signal-service bureau to establish a permanent signal-station at Point Barrow, and to remain there until the summer of 1884, unless otherwise ordered. The order for the party to return created great surprise, as the work was successfully carried on. Lieut. Ray stated, that, apart from the scientific importance of the station, it was a necessity, as a refuge for the crews of whaling-vessels. Every year, in the Arctic Ocean, there are, on an average, forty vessels, worth, with their cargoes, four million dollars, and employing sixteen hundred men. Out of eighty-seven vessels, fifty have been lost within a hundred miles of Point Barrow, in one year alone. In 1877 twelve were lost, with all on board. The crews would not abandon their vessels, knowing there was nothing on the shore. Had the station then existed, it is probable that all their lives would have been saved. Since the station was established, two years ago, over fifty lives have been saved. Lieut. Ray states, that all the party lived comfortably, and enjoyed good health, the climate being particularly beneficial to those suffering from malaria. Besides their regular provisions, the party had seal, walrus, and white whale meat; the last being the best, as it was sweeter and more nutritious. Lieut. Ray expressed regret at his recall.

— Lieut. Schwatka, who, with his party, was picked up by Lieut. Ray at St. Michael's, speaking of his trip up the Yukon River, Alaska, says they started from Fort Vancouver, W.T., on May 21, and travelled twenty-eight hundred miles overland, reaching the head waters of the river, where they constructed a raft of logs to navigate the stream to its mouth. They procured a crew of six Indians, and proceeded down the gradually increasing stream within two hundred and fifty miles of Fort Chilcat, where rapids were encountered. Down these the Indians refused to go, and attempted to force the raft ashore. Schwatka succeeded in suppressing the mutiny, and the rapids were run. The voyage on the raft was eighteen hundred and twenty-nine miles. From the mouth of the Yukon they proceeded to St. Michael's, where they boarded the Leo for this port. Signal-service officer Leavitt, who has been stationed at St. Michael's, and who also came down on the Leo, says he has ascended the Yukon to Fort Selkirk two thousand miles from its mouth. He describes the river as being one of the largest in the world, discharging fifty per cent more water than the Mississippi, and as being in places seven miles in breadth.

— Professor Oswald Heer, of the university and federal polytechnic school of Zurich, the celebrated Swiss paleontologist, died at Lausanne, Canton de Vaud, the 27th of September. Heer has done more for fossil botany and fossil insects than any one else during the last forty years, and his death will leave a place in science which it will be difficult to fill.

RECENT BOOKS AND PAMPHLETS.

Bernheim, G. Incombustibilisation des théâtres et bâtiments. Nice, *impr. Gauthier*, 1883. 16 p. 4°.

Berthelot, M. P. E. Explosive materials: series of lectures delivered before the College de France, Paris; to which is added a short historical sketch of gunpowder. Translated from the German of Karl Braun by J. P. Wisser, and a bibliography of works on explosives. New York, *Van Nostrand*, 1883. (Van Nostrand's sc. ser., no. 70.) 24°.

Bourassé, J. J. Histoire naturelle des oiseaux, des reptiles et des poissons. Tours, *Mame*, 1883. (Bibl. jeun. chrét.) 288 p., illustr. 12°.

Briggs, R. Steam-heating: an exposition of the American practice of warming buildings by steam. New York, *Van Nostrand*, 1883. (Van Nostrand's sc. ser., no. 68.) 108 p., illustr. 24°.

Brooks, W. K. The law of heredity: a study of the cause of variation and the origin of living organisms. Baltimore, *Murphy*, 1883. 2+336 p., 2 pl., illustr. 16°.

Browne, W. R. The student's mechanics: an introduction to the study of force and motion. London, *Griffin*, 1883. 16+210 p., illustr. 16°.

Campagne, E. Les mines, or, argent, fer, cuivre, plomb, étain, zinc, mercure, et platine. Rouen, *Megard*, 1883. (Bibl. mor. jeun.) 190 p., illustr. 8°.

Carrière, E. A. Étude générale du genre pommier, et particulièrement des pommiers microcarpes ou pommiers d'ornement, pommiers à fleurs doubles, etc. Mesnie, *impr. Firmin-Didot*, 1883. 179 p. 18°.

Foye, J. C. Chemical problems, with brief statements of the principles involved. New York, *Van Nostrand*, 1883. (Van Nostrand's sc. ser., no. 69.) 24°.

Freeman, E. A. English towns and districts: a series of addresses and sketches. London, *Macmillan*, 1883. 13+455 p., 11 pl., map. 8°.

Gladstone, J. H., and **Tribe**, A. The chemistry of the secondary batteries of Planté and Faure. London, *Macmillan*, 1883. (Nature series.) 11+59 p. 8°.

Gomme, G. L. Folk-lore relics of early village life. London, *Stock*, 1883. 8+246 p. f°.

Grant, B. A few notes on St. Helena, and descriptive guide. To which are added some remarks on the island as a health resort, Capt. J. R. Oliver's geology of the island, and numerous appendices. St. Helena, *Grant*, 1883. 127 p., 8 phot. pl. 8°.

Haeckel, E. The pedigree of man and other essays. Translated by E. B. Aveling. London, *Freethought publ. co.*, 1883. 15+352 p., illustr. 16°.

Kiddle, H. A text-book on physics, being a short and complete course, based upon the larger work of Ganot; for academies, high schools, etc. New York, *Wood*, 1883. 272 p., illustr. 8°.

MacLeod, J. Leiddraad bij het onderwijzen en aanleeren der dierkunde. Algemeene dierkunde. Gent, *Vuylsteke*, 1883. (Willems-fond, uitgave 104.) 4+151 p., 1 pl., illustr. 16°.

SCIENCE.

FRIDAY, OCTOBER 26, 1883.

THE VIVISECTION QUESTION.

The book we take as the basis of our remarks,[1] originally published in England, is one of several recent signs that British physiologists are at last coming to their senses; and, instead of attempting to conceal the fact that they experiment on animals, have decided to explain to the general public what a vivisection is, and why vivisections are necessary. Philanthropos, who is evidently well informed, discusses without passion or prejudice such topics as, 'What is pain?' 'What is cruelty?' 'Our rights over animals,' 'What is vivisection?' 'The relation of experiment to physiology,' 'The relation of medicine to experiment,' and so forth. If our colleagues across the water had, some seven or eight years ago, shown sufficient courage to trust to the common sense of the majority of their countrymen, and had endeavored to inform the laity by securing the publication and distribution of some such book as this, the anti-vivisection legislation could hardly have been enacted. Its passage, and the still-continued agitation for an act of Parliament totally forbidding all experiment on living animals, prove that the public did not and does not know enough about the matter to save itself from being misled by the reckless misstatements of irresponsible fanatics, and of certain seekers after notoriety or salary.

People in general do not read official blue-books: so, in spite of the fact that the royal commission appointed to investigate the matter reported, that, after prolonged and careful inquiry, it could find no evidence that English physiologists were guilty of cruelty, it has been possible for certain anti-vivisectors, by a persistent course of malignant vituperation and brazen mendacity, to produce a wide-spread belief that vivisection essentially consists in torturing an animal for the object of seeing how much it can suffer without dying. That such is the actual conviction of many worthy men and women in England, we know to be the case. The physiologists kept silent, and left the field to their enemies, with disastrous result; no one, not a brute, who believed half the stories circulated, could fail to hate physiology and physiologists. When the railroad-stations of England were placarded with large figures of dissections of dead animals, accompanied by printed words designed to entrap the general public into the belief that they represented vivisections of living creatures; when a text-book of practical physiology, designed only for special students of physiology, was represented far and wide as intended for use by every crude medical student; when the fact that the words 'first give an anaesthetic' were omitted (as they are in text-books of surgery, the administration of an anaesthetic being, of course, assumed in cases where very special reasons for its omission do not exist) in the directions for the performance of certain operations, was used as proof that physiologists never thought of employing means to prevent or minimize pain; when a law was passed which allows any one to torture a frog in the most brutal manner if he says he does it just because he likes it, but subjects a university professor to fine and imprisonment if he draws a drop of blood from the animal's toe for a scientific purpose, — then it had certainly become time for the physicians and physiologists of the British Isles to endeavor to inform the public on the vivisection question.

The anti-vivisection craze has now spread to Germany, and there are premonitory symptoms in the United States. Our people in general are too well informed, and have too great confidence in scientific men, to be so easily led

[1] Physiological cruelty; or, fact *v.* fancy: an inquiry into the vivisection question. By Philanthropos. New York, *John Wiley & Sons*, 1883. 156 p. 8°.

astray as the English have been. We shall, moreover, be free from the pressure of a royal court which dislikes biological science, and from the influence of the personal prejudices of the sovereign, still powerful enough in England to have much weight in legislation on questions outside of Whig and Tory politics. Still, American physiology is by no means secure, unless its leaders take warning by the English disaster. They have, in consequence of British legislation, an opportunity to make the United States the chief seat of physiological research among the English-speaking peoples; and it will be a lasting disgrace to them if they let it slip. If, while freely admitting that they believe it their duty to experiment on living animals, they will be on the alert to correct at once the falsehoods and exaggerations of the fanatics; to take pains to teach the public how much the scientific treatment of disease depends on physiological, therapeutical, and pathological research; and to make it widely known how very small a percentage of vivisections involve more pain than that felt by a man on receiving a hypodermic of morphia, — then there is little doubt they will be allowed to carry on without hindrance their beneficent work. The only danger lies in the ignorance of the great majority of ordinarily well-informed people regarding such subjects. Secrecy, not publicity, is what American physiology has to fear.

A HEARING OF BIRDS' EARS.[1] — II.

Let us next confine attention to the ossicles of the ear. Those familiar with these little bones, only as they occur in man or any other mammal, need to be cautioned that their anatomical arrangement, and to a great extent their physiological characters, are very different in birds and other reptile-like vertebrates. Presuming, of course, upon the reader's thorough knowlege of the human case, we will demonstrate these bones in their proper relations and offices in birds, as elements of the lower jaw and hyoid bones (mandibular and hyoidean arches).

The malleus is the proximal element of the meckelian cartilage (figs. 1, 2, *mk*), a gristly rod about which the lower jaw-bone is developed in membrane. Becoming segmented off from the rest of the meckelian rod, it is in mammals withdrawn into the tympanic cavity, disconnected from the jaw-bone, and connected with the incus, its *processus gracilis* lying in the glaserian fissure. The jaw-bone then articulates directly with the glenoid cavity of the squamosal, forming the temporo-maxillary articulation. In any bird the malleus remains outside the ear, and acquires comparatively enormous dimensions, with the peculiar shape shown in fig. 1, *q* (see also fig. 2, *q*). This

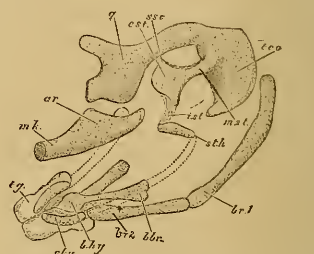


Fig. 2. — The post-oral arches of the house-martin, at middle of period of incubation, lateral view, × 20 diameters. *Mk*, stump of meckelian or mandibular rod, its articular part, *ar*, already shapen; *q*, quadrate bone, or suspensorium of lower jaw, with a free anterior orbital process and long posterior otic process articulating with the ear-capsule, of which *teo*, tympanic wing of occipital, is a part; *mst*, *est*, *sst*, *ist*, *sth*, parts of the suspensorium of the third post-oral arch, not completed to *chy*: *mst*, medio-stapedial, to come away from *teo*, bringing a piece with it, the true stapes, or *columella auris*, the oval base of the stapes fitting into the future *fenestra ovalis*, or oval window, looking into the cochlea, or inner ear; *sst*, supra-stapedial; *est*, extra-stapedial; *ist*, infra-stapedial, which will unite with *sth*, the stylo-hyal; *chy* and *bhy*, cerato-hyal and basi-hyal, distal parts of the same arch; *bbr*, *br*1, *br*2, basi-branchial, epi-branchial, and cerato-branchial pieces of the third arch, composing the rest of the hyoid bone. (After Parker.)

quadrate bone, as it is called in birds, looks something like an anvil, and has often been mistaken for the incus: on the other hand, from its function in supporting the *membrana tympani* in part, it has been malidentified with the tympanic bone (external auditory process). It is very freely articulated at both ends, rocking back and forth with the movements of the jaws. It normally has articulation with five separate bones: 1. By its lower end, which is bituberculur, with the articular piece of the mandible (lower jaw), forming the true temporo-maxillary articulation; 2. By the outer extremity of its lower end with the quadrato-jugal bone (fig. 1, *qj*), which is the posterior element of the zygomatic arch, continued forward by the jugal or malar bone (fig. 1, *j*) to the superior maxillary (fig. 1, *mx*); 3. By the inner extremity of its lower end with the ptery-

[1] Continued from No. 34.

goid bone (fig. 1, *pg*), and so with the palate-bone (fig. 1, *pa*) and superior maxillary (*mx*), 4, 5. The head of the bone normally articulates both with the squamosal (fig. 1, *sq*) and with the pro-otic (fig. 1, *po*, here seen inside the cranial cavity). A long spur of the quadrate, its orbital process, projects freely into the orbital cavity, as shown in fig. 1, where the still cartilaginous tip of the orbital process reaches to the round white hole marked 2 (*optic foramen*). Now, the osseous articulations and muscular tractions are such, that, when the mouth is opened, the malleus rocks forward upon its squamosa-petrosal articulation (4, 5, of above enumeration), and pushes upon the zygomatic and pterygo-palatal bars, causing the upper mandible to rise as the lower jaw is depressed; the upper jaw hinging upon elasticity of, or a joint at, the bones of the forehead. Thus the malleus-quadrate is here seen in its proper relation to the jaw-parts as nothing at all of an *ossiculum auditus*, except in so far as it hinges upon parts of the temporal bone, and helps to support the ear-drum. It has no direct connection whatever with the rest of the ossicles.

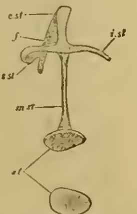


Fig. 3. — Mature stapes of fowl, about × 4. (After Parker.) *st*, its foot, fitting *fenestra ovalis*; *mst*, main shaft, or medio-stapedial element; *sst*, supra-stapedial; *est*, extra-stapedial; *ist*, infra-stapedial, its end representing a rudimentary stylohyal; *f*, a fenestra in the extra-stapedial. (See *st*, *in situ*, fig. 1, and its embryonic formation, fig. 2.)

It will be best to take the stapes next. Fig. 3 shows the mature stapes of the domestic fowl, enlarged about four times, and indicates its several elements which have received special names. It is practically the same bone so named in man, but includes incudial as well as some other elements. In form it is not at all stirrup-like, being trumpet-shaped, with a slender cylindrical shaft, expanded oval foot, and a crossbar and other pieces at the distal end. It is therefore oftener called the *columella auris*, or sounding-post of the ear. In skulls prepared with sufficient care, the stapes may be seen *in situ*, as in fig. 1, *st*, — an extremely delicate rod, stepped into the *fenestra ovalis* by its foot, the other end protruding into the tympanum, and bearing the additional hammer-like or claw-like elements. A stapes I have just picked out of an eagle's ear is a fourth of an inch long, with a stem as fine as a thread of sewing-silk, but a stout foot, and, at the tympanic extremity, a still finer hair-like process half as long as the main stem, from which it stands out at right angles: while there appears to have been another similar claw, which has broken off from such a cross-like object as *st* in fig. 1.

Embryological study is required to demonstrate the stapes as the proximal element of the hyoidean apparatus, quite as the malleus is of the mandibular arch. Reference to fig. 2 should make this clear. Here the malleus, *q*, extends from *teo*, the tympanic wing of the exoccipital, to *ar*, the articular element of *mk*, the meckelian rod whence *q* has been segmented off, leaving the 'temporo-maxillary articulation' between *q* and *ar*. This chain of bones, including others to be developed about and beyond the stump of *mk*, is the lower jaw, or mandibular arch. Now, quite a similar arrangement is shown in the chain of bones in the tongue or hyoidean arch. From *teo* stands off a rod of bone, *m st*, the medio-stapedial element, or main shaft of the stapes, to be segmented away from *teo*, the place of this segmentation to become the fenestra ovalis. The medio-stapedial rod expands at its end; the upper part of the expansion, never separating from the rest, is the supra-stapedial element = mammalian incus, *s st* in figs. 2, 3. An infra-stapedial element, just forming in fig. 2, *ist*, completed in fig. 3, *ist*, connects with the piece marked *st h* in fig. 2. This *st h* is the stylohyal = human 'styloid process of the temporal,' which connects in man by the 'stylo-hyoid ligament,' with the 'lesser cornu of the hyoid bone,' which is the cerato-hyal, *c hy*. In birds, the distal parts of the hyoid arch (composed of the numerous pieces lettered in fig. 2, but which need not longer detain us) become entirely separated from the proximal, the tongue-bones being quite otherwise affixed to the skull; while the proximal parts of the same arch are shut up in the tympanic cavity, where they extend from the *membrana tympani* to the *fenestra ovalis*, constitute all there is of *ossicula auditus*, and consist of the stapes itself (including the several elements specified).

So, therefore, avian malleus or quadrate-bone = human malleus as proximal element of mandibular arch, retaining articular connection with its own arch, but not acquiring character or connections of a human *ossiculum auditus*.

So, therefore, avian stapes or columella = human stapes + incus, as proximal elements of hyoidean arch, not retaining connection with its own arch, but acquiring characters and connections of *ossicula auditus*.

These are the reasons why a bird's lower jaw does not articulate directly with the squamosal, why the hyoid bones do not articulate at all with the skull, why the malleus is outside the ear, and why there is apparently but one ossicle in the tympanum, of the particular shape shown in fig. 3.

(*To be continued.*)

THE PSYCHOLOGICAL MECHANISM OF DIRECTION.

Were it admissible that one person should add to the work of a living author, I might call this paper a supplement to Mr. Francis Galton's Human faculty. My object is to explain the subjective mechanism by which I preserve the consciousness of direction. How far others adopt the same mechanism, I am not fully aware, but am inclined to think that what is fundamentally the same system is employed by nearly every one; but I doubt whether the details are always the same, and the matter appears of sufficient interest to be discussed.

To be conscious which way he is going, one must keep in mind some system of directions. It is true, that, so far as finding one's way about in a place with which he is fully acquainted is concerned, no attention to direction is necessary. One knows that he must turn here to the right, and there to the left, and must follow certain familiar paths, all of which he can do without attending to direction. It is probable that most animals, and possible that some men, have no system except this. Regarding such a limitation as exceptional, we must suppose that in general, men, in going about, have constantly in mind an idea that they are going in a certain definable direction. A direction can, however, be defined only by reference to the direction of some line taken as a standard of reference; and it is this standard of reference, as I have always employed it, which I shall now describe.

I. I continually carry around with me a conception of four horizontal lines, which I shall call co-ordinates, going out in four cardinal directions. I shall call these directions east, west, north, and south; but it must be understood that they have no necessary relation to the actual points of the compass, being purely subjective. This system of co-ordinates is employed, I think, by most or all men.

II. These four cardinal directions are conceived of as *absolute* directions, and not as defined relatively to any particular line on the earth's surface. They have remained unchanged since the earliest memories of childhood. To be more explicit, the ideal or subjective west is the direction in which I was facing, when, as a child, my father explained to me which was the right hand, and which the left; the ideal north is the direction towards which my right side was then turned; the ideal south, that towards which the left side was turned: while east was behind my back.

I have always since imagined myself as conscious of these four absolute directions, and therefore at any moment can face as I imagine myself to have been facing on the occasion referred to. I do not know whether the co-ordinates have the same absolute character with other men, but think it highly probable that they do, since absolute directions must be more easily thought of than relative ones.

III. With some limitations, to be soon referred to, the system of directions is quite independent of the will. Once fixed in a place, a street, or a house, they are an inseparable component of the situation, and forever unalterable so long as the identity of the place is recognized. Once in a room of which I conceive a certain side to be the absolute west, by no act of the will, and by no consciousness that some other side is the west, can I change the subjective impression. Of course, however, one is liable on going into a strange place, or on walking about without sufficient attention, to be mistaken as to his direction; and thus I am subject to a kind of trouble or confusion which I never heard any one else describe, and which, therefore, I can hardly suppose to be universal. Some instances will illustrate the matter better than general statements.

I recently went to a hotel in Paris, where I had stopped eight years before. While driving into the court, and just as the carriage was stopping, my attention was momentarily occupied in speaking to one of the attendants. Getting out of the carriage, I remarked, as I supposed, that the offices of the hotel had all been moved from the north to the west side of the court. I may anticipate by saying that this was an illusion arising from the very minute circumstance that the carriage, during the moment that I was speaking to the attendant, had turned at a right angle from facing north to facing east; but being unconscious of this change, and not looking around the court, I supposed that the carriage was still directed towards the ideal north. I entered the elevator, was carried to an upper story, shown through several long passages, and into a room, preserving the changed system of co-ordinates of which I was entirely unconscious. Had it been my first visit to the hotel, no confusion would have resulted, since every thing around it would have been referred to this same system; but I entertained a distinct idea of the orientation of the rooms around the court as they existed in my mind during my former visit. The result was, that when I went down to dinner I found my co-ordinates 90° wrong. But I was absolutely powerless to refer the two parts of the hotel to the same system. During the week that I remained, whenever I went from my room down-stairs, to the court, the reading-room, or the dining-room, there was a momentary confusion on reaching the point where I saw that the system was wrong. Momentary glances around, and the co-ordinates changed 90°. On returning to my room, the co-ordinates below were carried up-stairs with me, because there was nothing on the stairway with which I had become sufficiently familiar to fix either set of co-ordinates; and thus one system obliterated the other, as it were. In consequence, I could carry one set all the way down, and another set all the way up; the change occurring at the bottom of the stairway in one case, and at the top in the other. The result was, that during my stay I got no clear idea where my room was situated, or what buildings I saw through the window.

To mention another instance: I lived for a number of years in a house in which I must have made a similar mistake the first time I entered it; since, during my whole stay, the orientation inside the building was 90° different from that outside. In the case of such an inconsistency as this, I find that the orientation corresponds to that of the place to which the attention is directed. So long as I was inside a room, or so long as my attention was directed to things inside the house, there was one orientation. On raising the window, and taking a good view of the street, I would perceive that this orientation was 90° in error; and after a momentary confusion the street would assume its right direction. The reverse change would recur on turning back to the room.

I find this occasional inconsistency of orientation, to which I am very liable when I pay no attention to directions on first entering a house, to be really troublesome. It has twice happened quite recently, that, on going upstairs in a hotel on my first arrival, I got the co-ordinates reversed 180°. The result was, that unless I staid long enough to go right by mere habit, without thinking about the direction, I was continually in doubt about which way I should go to find the room I wanted.

IV. I find that this fixity of co-ordinates holds in any kind of a building, and in a ship, but not at all in a carriage, and not absolutely in a railway-car. If I am conscious, by looking at surrounding objects, that a railway-car turns 90°, I can change its relation to the system of co-ordinates accordingly. It appears, therefore, that it is only in fixed structures that the co-ordinates inure in my conceptions of enclosed space; yet I feel perfectly sure, that, if a house in which I lived be turned through 90° or 180°, the system would turn with it, in spite of any thing I could think to the contrary.

V. I now come to the modifications of fixity to which I have already referred. The imaginary sense of direction is not absolutely always present. In travelling over a new road to a new place, the sense of direction is, for the time being, apt to be lost. In this case, and in this alone, it is to a certain extent under control of the will; but, if the will fails to act promptly on arriving at a place, the co-ordinates fix themselves, as it were, and that quite arbitrarily, so far as I have been able to perceive. Once fixed, they stay. But, while under control of the will, I am in the habit of so directing them that the ideal directions shall correspond to the points of the compass, in case I know them.

VI. I have recently noticed that it is not necessary that I should actually have seen a place, in order that the co-ordinates should be fixed in it. If I study on a map a place which I am to visit, I unconsciously fix the co-ordinates to correspond to the points of the compass. Thus, on arrival, I readily find my way about. But it may happen, that, when I arrive, I am mistaken as to the direction in which the railway-station stands. Then, take what pains I will, the same confusion arises when I arrive at a street or hotel which I have studied on the map, and find the co-ordinates to be wrong. The directions change to those in which I have thought of the house or street.

Of this fixing of the co-ordinates in advance, I recently had a curious example. I got on board a steamship at Liverpool, resolving that the ideal and real west on board ship should correspond. I went down to seek out my state-room, and, on returning to the deck, I was chagrined to find that the co-ordinates had got changed 180°. In consequence, I had to think before knowing which side of the ship I looked at. For some time I was puzzled to imagine how the mistake could have occurred. I finally traced it to the fact, that, on studying the position of my state-room on the plan of the ship a month before, I had held up the plan with the stern in the direction in which west is on the map. I constructed the orientation of the passageway and of the stateroom accordingly. It happened, that, when I joined the ship, her stern was towards the east; but, on descending into the cabin for the first time, I fixed the orientation to correspond to the one previously formed from the plan, forgetting at the moment that I was thus making a change of 180°.

VII. A universal law of the four cardinal directions is, that they always arrange themselves along visible lines, such as roads, boundaries of a room, etc.: in other words, the directions never subdivide themselves. In going along a new road which I know ought to bisect the angle between two directions, I can, by an effort of the will, imagine it to do so; but, the moment attention is relaxed, one cardinal direction is sure to take possession of the road, and of course, once in possession, keeps it: so, no matter how well I may know that the walls of a room are at an angle of 90° with the other walls of a building, the directions are sure to arrange themselves parallel to the walls.

It may be asked, How does this system work, in case of a number of rooms radiating like a fan from a central space? I answer, that in such a case my ideas of direction simply get unutterably confused, and only by long habit can I get the relations of the different rooms to each other. SIMON NEWCOMB.

THE ARAGO LABORATORY AT BANYULS.

AMONG the zoölogical stations or laboratories along the coast of France, none is more widely known or more firmly established than the laboratory at Roscoff,[1] in Finisterre, organized in 1872 by Professor Lacaze-Duthiers as an adjunct of his zoölogical laboratory of the Sorbonne at Paris. Encouraged by the success of his laboratory at Roscoff, which during August, 1881, had twenty-five workers, but which, owing to its exposed position at the north-west extremity of France, was only available for work from March until October, at the most, Professor Lacaze-Duthiers sought to establish a winter laboratory on the Mediterranean, to furnish seaside work the remaining months of the year. After careful examination of the French coast of the Mediterranean, a location was chosen for the laboratory at the base of the rocky promontory of Fontaulé, at the entrance of the little harbor of Banyuls-sur-mer, within a few miles of the Spanish frontier in the department of Pyrénées-Orientales.

The municipal council of Banyuls, through the mayor, M. Pascal, who took much interest in the establishment of the laboratory, offered a site for building, twelve hundred francs for immediate use, and an income of five hundred francs annually for twenty years; M. Thomas, a wealthy gentleman of Banyuls, offered two hundred and fifty francs annually for ten years, and a boat; the council of the department of Pyrénées-Orientales voted twenty thousand francs toward the construction of the laboratory; and subscriptions were received from the citizens of this rich wine-producing neighborhood. These were some of the means employed to induce Professor Lacaze-Duthiers to locate at Banyuls. Port Vendrès, a neighboring village, offered inducements to locate there; but the great number of fishermen in Banyuls, its nearness to the open Mediterranean, and its freedom from the distractions due to commercial and other activities, together with the earnest interest taken by its inhabitants in the laboratory, won the choice of that village. What a novel sight it would be, here in America, to see villages contesting for the honor of possessing a scientific laboratory! The Academy of sciences at Paris took the laboratory under its protection; and the establishment was called 'Laboratoire Arago,' to honor the name of the most distinguished *savant* of the Pyrénées-Orientales, a former member of the academy.

It is, of course, impossible to speak of much work already accomplished at the Arago laboratory, as one might describe studies completed at Roscoff; for the laboratory at Banyuls was scarcely finished in the winter of 1881–82, when, with another American and a French student, I had the pleasure of being one of the first to work within its walls: so I will write only of the region and of the laboratory.

The eastern end of the Pyrenees descends suddenly upon a north and south coast by a series of radiating ridges, between which are small indentations of the sea, forming harbors, with rocky promontories at each side of their entrances, and a sandy beach within. This kind of coast offers numerous advantages to those searching for marine animals. On each of the larger of the beaches are villages, most of which date back to Roman times. These villages were recently connected by a railroad which follows the coast, passing through tunnels between them.

Banyuls is situated upon one of these beaches, at the head of a small harbor, which is partly

[1] For a detailed account of the laboratory at Roscoff, with maps and plans, see *Revue scientifique*, Nov. 26, 1881, xxviii. 673–680.

protected from the open sea by a breakwater (seen in the middle of the first picture at the left of the laboratory), which extends from the promontory, at the base of which the laboratory is built, to a rocky island in the middle the entrance to the harbor. The village of Banyuls itself (seen in the other illustration, looking from the laboratory into the harbor) has about four thousand inhabitants. Behind the village the hills are clothed with vineyards, olive-groves, and cork-oak trees, nearly to their tops. To crown the view is the middle-age tower of Madeloth, or *Tour du Diable*, on a mountain six hundred and sixty-eight metres high. The village has two hotels, which are crowded with bathers during midsummer. In winter there are few amusements, and the hotels are then nearly empty. For a good concise description and history of this region, in which the Catalan dialect still prevails to a considerable extent, and the history of which is extremely interesting, I refer to Pierre Vidal's *Guide historique et pittoresque dans le département des Pyrénées-Orientales*, Perpignan, 1879. M. Vidal is the assistant librarian of the town of Perpignan, capital of the department.

The climate of Banyuls is sufficiently moderate to make a winter's stay very agreeable. Oranges, figs, cactuses, almonds, and even the date-palm with poorly developed fruit, are cultivated in the valleys. In the latter part of February, 1882, I waded along the beaches in search of mollusks, without finding the cold inconvenient. Snow rarely falls. The climate can be shown best by quoting a table for 1882, from Martinet,[1] as follows (*degrees in Centigrade*) : —

Month.	Temperature.					Number of days of	
	Extremes.		Means.				
	Minimum.	Maximum.	Minimum.	Maximum.	Total.	Rain.	Wind.
January	2.0	15.0	5.0	11.7	8.4	3	1
February . . .	1.5	19.5	6.4	13.1	9.7	3	7
March	4.0	23.0	9.3	16 9	13.1	5	9
April	7.5	26.0	10.6	18.6	14.6	8	7
May	10.0	27.5	14.7	22.7	18.7	3	3
June	13.5	34.5	17.6	26.5	22.1	4	9
July	16.0	38.5	19.3	28 3	23.8	3	11
August	13.0	35.0	19.9	28.1	24.0	7	6
September . . .	10.5	28 0	12.9	20.4	17.1	13	2
October	9.5	27.0	13 3	19.8	16.5	6	8
November . . .	5.0	19.0	8.7	15.5	12.1	4	8
December . . .	1.0	16.0	6.7	11.6	9.2	8	3
Means of the year,	–	–	12.1	19.4	15.8	67	74

[1] L. Martinet, Banyuls sur mer (*Rev. géogr. internat.*, April, 1883, 8e ann., 67).

The lowest temperature of which I find data was − 6° C., in January, 1871. The cold winds which sometimes descend from the mountains, blowing with considerable severity for one or two days at a time, are the only unpleasant climatological feature of the region.

I have been unable to find sufficient data in regard to the temperature of the sea-water at Banyuls. Martinet writes (*l. c.*, May, 1883, p. 85), "From the month of May the temperature of the sea is 18° ; that of the air, in the shade, from 30° to 35°. In July and August the temperature of the water reaches 24° to 26° ; then in September and October it descends from 22° to 18°."

The marine fauna at Banyuls is very rich. Several species of corals and of actinias, and numerous species of interesting mollusca, such as Chiton and Haliotus, can be taken on the rocks within a few metres of the laboratory. Besides these, the janitor in charge regularly transplants new species to the vicinity of the laboratory. Siphonophores, ctenophores, and tunicates swarm in the waters. It would be useless to mention here the numerous forms which are found on every side without the aid of the dredge ; and, when the dredge is used, the result is almost incredible. Add to this the habit already acquired by the fishermen of bringing to the laboratory all curious animals which they find in their nets, and we have a place where unsurpassed opportunities are offered for obtaining material in quantity for study, an opportunity of which I availed myself, in order to study the parasites of fishes and crustaceans. The fishing at Banyuls, excepting that for sardines and anchovies, is carried on by the use of a large funnel-shaped net, held open, and drawn through the water by two boats, which stand a distance apart. Numerous sharks and cephalopods, — both eaten by the people at Banyuls, — and sometimes sunfishes (Orthagoriscus) and other large fishes, are taken in these nets, besides smaller fishes by thousands.

About fifty fishing-boats, like those seen in the second illustration, leave Banyuls early every pleasant morning, returning about five o'clock in the afternoon, when the fish are spread out for sale along the beach. This mode of sale is a convenience for the naturalists as well as for the townspeople : on the contrary, in fishing-places near large cities, the fish are hurried aboard the trains, leaving no opportunity for their examination. The fresh entrails of fishes can be examined by thousands on the beach at Banyuls, for parasites or for anatomical purposes.

The terrestrial and aerial fauna offers abundance of water-birds, lizards, geckoes and insects, scolopendra and scorpions.

The Arago laboratory is a brick and stone building, about forty metres long and ten metres wide, facing nearly northward. The illustration is a view of the laboratory looking nearly southward from the village. The ground-floor of the laboratory is devoted to a small room for the janitor, another for apparatus, and to a large room for aquaria. In the centre of the last room is a large oval aquarium, and about the room are smaller aquaria to be devoted to special purposes. The water from these aquaria passes out of the front of the building, and supplies other aquaria in the open air. It is, however, upon the first floor that the arrangements made by Professor Lacaze-Duthiers attain the maximum of convenience. A hall runs lengthwise through the middle of the laboratory; and from this hall open out at each side the separate rooms, consisting of a store-room for glassware, a lecture-room, a library, a room for the director, and nine rooms for work. Instead of having a table, as is the usual mode in laboratories, each worker has a room (four metres square) to himself, wherein he can carry on researches undisturbed by his neighbors. As the laboratory is intended for advanced students pursuing original investigations, this provision is of special importance. Sitting on a revolving-chair in the middle of his room, the worker has upon his right a table for drawing; in front, toward the large window, — which, with the climate of Banyuls, can be open much of the time, — is a table for his microscope and apparatus; at his left, a table for specimens. Turning to his right, the investigator can write his notes and draw, free from the danger of water from his larger specimens. This arrangement of tables in three sides of a square, with a revolving-chair at the centre, is an idea original, as far as zoölogical laboratories are concerned, with Professor Lacaze-Duthiers; and, after having used for a time tables thus arranged, one never is exactly at ease when they are placed otherwise. As if these were too meagre furnishings for each room, another table, a bookcase with drawers, and shelves, are added. A flowing supply of salt water will be, or probably is already, available for small aquaria in each of these work-rooms. Three of the rooms have chimneys, and are more especially desirable for physiological researches. The second floor is not yet used, but probably will be ultimately partitioned into sleeping-rooms for those who work in the laboratory.[1]

ARAGO LABORATORY, SEEN FROM BANYULS.

The laboratory possesses already, besides two rowboats for collecting along the indentations of the coast, a new boat of the same general construction as are the fishing-boats of

[1] For a detailed description and plans of the Arago laboratory, see the *Revue scientifique*, Dec. 3, 1881, xxviii. 705–715.

the region, with a lateen-sail, but considerably larger for long voyages. This boat is commanded by an experienced fisherman of Banyuls, who is conversant with the whole neighboring coast.

The almost entire absence of rise and fall of the water at Banyuls at first puzzles a collector of marine animals accustomed to searching the rocks bared by the receding tide: but one soon finds other and equally productive modes of shore-collecting; while the very absence of great variation in the level of the water enables one to moor boxes of embryos along the inside of the breakwater, and watch their development at leisure.

The expenses of living in Banyuls are about what they would be in a village of the same size on the New-England coast; but the laboratory, like that at Roscoff, is free, requiring for its use only the permission of Professor Lacaze-Duthiers. Reagents, microscopes, mounted dissecting-lenses, glassware, and all other necessary apparatus, are furnished free, the only cost being a small fee paid to the janitor for the care of rooms. While, in all probability, preference would be rightly given to Frenchmen, in case there were more applicants for places than there were rooms, yet foreign investigators will undoubtedly play an important part in the laboratory at Banyuls, as they have already done in that at Roscoff, and will return to their native countries vividly impressed with the liberality and devotion to science shown by Professor Lacaze-Duthiers.

GEO. DIMMOCK.

BANYULS AS SEEN FROM THE LABORATORY.

AUGUST REPORTS OF STATE WEATHER-SERVICES.

THE states in which organized weather-services exist have issued reports for August which give in some detail the results of the observations. The special feature of the month in the majority of states seems to have been the lack of rain, and the consequent drought.

Georgia. — The temperatures ranged from 47° to 98°: the mean was 79°.3. The rainfall ranged from 1.01 inches in the south-west to 9.15 inches in the south-east. The general drought of the summer was unbroken. The cotton and corn crops do not average 75 % of the usual yield.

Indiana. — Thunder and lightning were unusually prevalent, but the rainfall was at least one inch less than the average. The temperatures were lower than usual, and light frosts were reported on the 24th and 25th. The pressure was nearly normal, with a small range.

Iowa. — "The month was cold, clear, dry, with north-westerly and south-easterly winds equally frequent, and calms numerous." The low mean temperature, 2°.5 below the normal, is mainly due to the first decade; but in this period the sunshine was especially intense. The number of fine days, and the dry, sunny weather, have been favorable to the crops. Frosts were recorded on the 22d, 23d, and 24th. There was a very severe hail-storm on the 7th, extending from Sac to Cass counties.

Missouri. — The mean temperature was below the normal, at St. Louis 2°.3 lower. The rainfall was less than the average, the amount at the central station in St. Louis being not much more than half the usual quantity. The heaviest rainfall was on the southern border of the state. In consequence of the continued drought, the crops have suffered much. A few wind and hail storms were reported.

Nebraska. — There are thirty-one observers, from whose reports it is found that the temperature and rainfall were about normal. The average mean temperature was 75°.4; average rainfall, 3.43 inches. The highest of the maximum temperatures was 93°; the lowest of the minimum, 47°. A violent hailstorm occurred on the 8th, at Lincoln; and a wind of forty four miles per hour, from the east, was noted at North Platte.

Ohio. — The barometric pressure was unusually steady, the small range of 0.542 inches being noted. The mean temperature, 68°.2, is more than four degrees below the average. A minimum of 39° was noted. Rain fell on seven days only. The average rainfall was only 1.88 inches, the usual amount being 3.47 inches. At Lebanon 4.60 inches fell, and at Granville 0.70 inch. A violent storm of wind and hail visited Wooster and vicinity on the 28th.

Tennessee. — The reports are from thirty-five stations. The highest of the maximum temperatures noted was 94°, and the lowest of the minimum 43°. The ranges of temperature were generally uniform throughout the state; but the precipitation, which ranged from 1.03 to 6.38 inches, was quite unevenly distributed. The weather presented no remarkable features. There was a marked absence of high winds or severe electrical disturbances. The crop reports are excellent, but the average condition is a little below that of last year.

THE GEOGRAPHIC CONTROL OF MARINE SEDIMENTS.

M. A. Rutot, conservator in the Royal museum of natural history of Belgium, who, in connection with M. E. Van den Broeck, has been studying the tertiary strata of his country, has lately taken up (*Bull. mus. roy. hist. nat. Belg.*, ii. 1883, 41) the fruitful subject of the immediate dependence of fragmental marine deposits on geographic conditions, such as distance and form of shore-line, depth of water, currents, etc., and the consequent changes in these deposits following changes in the controlling geographic surroundings. The matter is properly treated deductively, and so far as concerns vertical oscillations of the earth's crust, which determine advance and retreat of the shore-line, it is examined with much detail. The conclusion is reached, that the frequent changes from gravels, through sands to clays, and back again to gravels, that characterize the Belgian tertiaries, can be fully explained by simple, assignable, and slow geographic causes. We have only to regret, that, in the forty pages devoted to the subject, more room was not found for mention of what others have done in the same direction. The method of investigation may be outlined as follows: —

There is first given the familiar illustration of the varied deposits forming off shore at any single time, showing that the texture, and, in part, the composition of the deposits, are functions of the distance from the shore-line, as in fig. 1. Now, let a general depression slowly take place, by which the sea will advance over the land: the whole set of deposits shifts with the shore, until sands, and at last clays, are laid down over the first gravels, as in fig. 2. Then, if elevation replace the depression, the set of strata shifts seaward, and the sands, and at last the shore-gravels, lie above the clays, as in fig. 3. It is generally noted that the upper gravels are finer than the lower, as the later deposits are made, in part, by working over the older during the time of emergence.

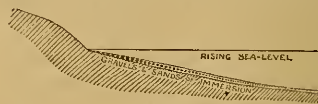


Fig. 1.

The complete set of deposits formed during such a double oscillation of sea-level is to be considered in two ways, — first, with regard to the vertical sequence of the strata; second, with regard to their horizontal equivalence. The vertical sequence is seen in fig. 4: it is made up of the gravels and sands of immersion, the central layer of clay, and the sands and gravels

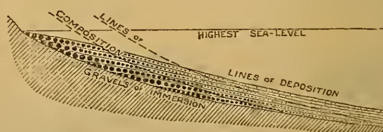


Fig. 2.

of emersion, each stratum having its appropriate fossils. Such 'circles of deposition,' enlarged by the addition of a limestone at the time of greatest distance of the old shore-line, occur several times in our Appalachian sections; and the recognition of their meaning, especially in Professor Newberry's luminous writings, has thrown much light on the evolution of our country. M. Rutot gives the accompanying figure (5) to illustrate the succession of unequal or incomplete oscillations: it shows, I., a large and complete

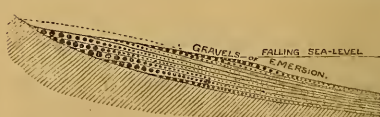


Fig. 3.

oscillation, partly eroded before II., a second depression, from which the elevation was incomplete; III., a great depression and complete elevation; IV., a moderate depression and elevation. This complicated succession represents perfectly the type of the Belgian tertiaries; and the deductions from its physical features are fully confirmed by the evidence from its fossils.

The second consideration, involving the horizontal equivalence of the different strata, is perhaps the most suggestive part of the paper. It is of much importance, and is seldom sufficiently treated. It involves the further examination of the dependence of a set of phenomena on their distance from some controlling condition, which can be called the directrix, and which may change its position. This is worthy of illustration. We find a simple case, in which the directrix is motionless, in the escape of

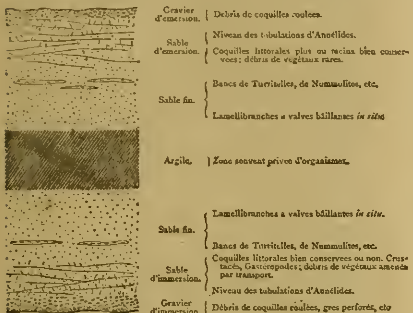


Fig. 4.

gases during a volcanic eruption. The eruptive vent is the directrix, and the various gases are successively given off from the lava when its temperature falls to that below which they cannot be occluded, the temperature depending largely on the distance of flow from the crater. An example in which the directrix moves continually in one direction is seen in the dependence of terrestrial day and night, with all their attendant changes, from warmth to cold, activity to rest, on the position of the sun. One in which the directrix moved for a time in one direction is seen in the relation of our drift-deposits to the

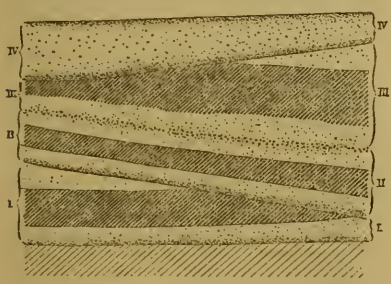


Fig. 5.

'retreating' margin of the continental ice. Far to the northward of the margin, where the ice was thickest and moved fastest, erosion was most active; at a less distance, the ground-moraine was accumulated at favorable points; at the margin, the Kame gravels were deposited; and farther south, the brick-clays settled where they found quiet water: hence all these may be chronologically equivalent in passing from south to north, although at a given point we should find a vertical sequence from scratched rock, through ground-moraine and Kame gravels to brick-clay. An effect of irregular motion of the directrix will be seen in the shifting of all those physical and chemical actions going on within the earth, and dependent for their proper temperatures and pressures on their depth below the surface; for this depth, or the distance from their directrix, is continually, though very slowly and irregularly, changing, — decreasing, while the superincumbent mass culminates in a land-surface that is losing ground by erosion; increasing, while it is receiving new material below the sea. A regular oscillation of the directrix is presented in the swinging of the sun north and south of the equator, carrying the seasons, the wind-systems, and the length of the day, in its train. Finally, the case in point shows us an irregular shifting of the shore-line directrix as the land slowly rises and falls. As a first result of the dependence of deposits on their distance from the shore-line, we shall find that those formations which are at any given moment contemporaneous, or horizontally equivalent, are the very ones already seen at any given point in vertical sequence. Secondly, when we view a broad set of deposits accumulated during a shifting of the shore-line, it will be seen, that while the band of conglomerate or sandstone is continuous for considerable distances, and apparently of contemporaneous formation throughout, it is not so in reality; for the lines of composition are not lines of deposition, and one part of the conglomerate is distinctly of later date than another, and really contemporaneous with the clay overlying the latter. This is illustrated in fig. 2, and shows the complete abandonment of the old ideas concerning universal formations. Instead of supposing that contemporaneous deposits are of uniform composition throughout, we must now admit that they necessarily vary.

M. Rutot's paper was prepared especially for the explanation of Belgian geology. Before it could serve as a guide to the meaning of our broad paleozoic strata, there should be added a consideration of the geographic conditions of limestone-making, and of the former greater strength of transporting agencies required by our old conglomerates. It would have been well to consider Phillips's suggestion concerning continuous subsidence at irregular rates, in which the shallowing is produced by deposition instead of by elevation; for, although this is quite inadequate to explain the changes in the heavy Appalachian sediments, where shallow-water sandstones sometimes quickly follow deep-water limestones or shales, it may serve in certain cases of smaller measure, which M. Rutot has interpreted as the effects of oscillations. On the other hand, the occurrence of elevation after and in spite of deposition might be emphasized to show the rather one-sided aspect of the conclusions lately discussed by the English geologists, who too often consider erosion and deposition as almost the chief causes of change of level.

THE DEVONSHIRE CAVERNS, AND THEIR CONTENTS.[1]

Anthropology, on one of its numerous sides, marches with geology; and hence it is, no doubt, that I, for many years a laborer very near this somewhat ill-defined border, have been invited to assist my friends and neighbors in the work which lies before them during the association week. I have the more cheerfully accepted the invitation, from a vivid recollection, that, when on a few occasions I have come uninvited into this department, my reception has been so very cordial as to lead me to ask myself whether the reports which for many years (1864 to 1880) I laid annually before my geological brethren did not derive their chief interest from their anthropological bearings and teachings.

In 1858, a quarter of a century ago, I had the pleasure of reading to the geological section of the association the first public communication on the exploration, then in progress, of Brixham Cavern (more correctly, Brixham Windmill-hill Cavern); and as any interest connected with that paper lay entirely in the evidence it contained of the inosculation and contemporaneity of human industrial relics of a rude character, with remains of certain extinct mammals, I purpose on this occasion to lay before the department a few thoughts, retrospective and prospective, which may be said to radiate from that exploration, confining myself mainly to South Devon.

Probably nothing will better show the apparent apathy and scepticism with which, up to 1858, all geological evidence of the antiquity of man was received by British geologists generally, than the following statement of facts: —

About the beginning of the second quarter of the present century, the late Rev. J. MacEnery made Kent's Cavern, or Kent's Hole, near Torquay, famous by his researches and discoveries there. He not only found flint implements beneath a thick continuous sheet of stalagmite, but, after a most careful and painstaking investigation in the presence of witnesses, arrived at the conclusion that the flints "were deposited in their deep position before the creation of the stalagmite" (*Trans. Devon. assoc.*, iii. 330); and when it was suggested by the Rev. Dr. Buckland, to whom he at once and without reservation communicated all his discoveries, that "the ancient Britons had scooped out ovens in the stalagmite, and that through them the knives got admission to the 'diluvium,'" he replied, "I am bold to say that in no instance have I discovered evidence of breaches or ovens in the floor, but one continuous plate of stalagmite diffused uniformly over the loam" (*Ibid.*, p. 334). He added, "It is painful to dissent from so high an authority, and more particularly so from my concurrence generally in his views of the phenomena of these caves, which three years' personal observation has in almost every instance enabled me to verify" (*Ibid.*, p. 338).

It is perhaps not surprising that Dr. Buckland, one of the leading geologists of his day, should be too tenacious of his opinion, and feel too secure in his position to yield to the statements and arguments of his comparatively young friend, MacEnery, then scarcely known to the scientific world.

That the position taken by Buckland retarded the progress of truth, and was calculated to check the ardor of research, is apparently certain, and much to be regretted. But it should be remembered, that, at least as early as 1819, he taught that "the two great points . . . of the low antiquity of the human race, and the universality of a recent deluge, are most satisfactorily confirmed by every thing that has yet been brought to light by geological investigations" (Vindiciae geologicae, p. 24); that early in 1822 he reiterated and emphasized these opinions in his famous Kirkdale paper (*Phil. trans.* for 1822, pp. 171–236), which the Royal society 'crowned with the Copley medal' (*Quart. journ. geol. soc.*, vol. xiii. p. xxxiii.); that in 1823, having amplified and revised this paper, he published it as an independent quarto volume under the attractive title of 'Reliquiae diluvianae,' of which he issued a second edition in 1824; and that though his acquaintance with Kent's Cavern was much less intimate than that of MacEnery, he nevertheless was, of the two, the earlier worker there, and, in fact, had discovered a flint implement in it before MacEnery had ever seen that or any other cavern, — the first tool of the kind found in any cavern, it is believed, and which in all probability was met with under circumstances not in conflict with his published opinion on the low antiquity of man. I confess that under such circumstances, human nature being what it is, the line followed by Dr. Buckland seems to me to have been that which most men would have pursued.

It was, at any rate, the line to which he adhered as late, at least, as 1837; for in his well-known 'Bridgewater treatise,' published that year, after describing his visit to the caverns near Liége, famous through the discoveries of Dr. Schmerling, he said, "The human bones found in these caverns are in a state of less decay than those of the extinct species of beasts: they are accompanied by rude flint knives, and other instruments of flint and bone, and are probably derived from uncivilized tribes that inhabited the caves. Some of the human bones may also be the remains of individuals, who, in more recent times, have been buried in such convenient repositories. M. Schmerling . . . expresses his opinion that these human bones are coeval with those of the quadrupeds of extinct species, found with them, — an opinion from which the author, after a careful examination of M. Schmerling's collection, entirely dissents" (*Op. cit.*, i. 602).

It may be doubted, however, whether his faith in these his early convictions remained unshaken to the end. I have frequently been told by one of his contemporary professors at Oxford, who knew him intimately, that Buckland shrank from the task of preparing for the press new editions of his 'Reliquiae diluvianae' and his 'Bridgewater treatise.' 'The work,' he said, 'would be, not editing, but re-writing.'

[1] Address by William Pengelly, F.R.S., F.G.S., vice-president of the section of anthropology of the British association for the advancement of science. From *Nature*.

Mr. MacEnery intended to publish his 'Cavern researches' in one volume quarto, illustrated with thirty plates. In what appears to have been his second prospectus, unfortunately not dated, he said, "The limited circulation of works of this nature being by no means equal to the expenses attendant on the execution of so large a series [of plates], the author is obliged to depart from his original plan, and to solicit the support of those who may feel an interest in the result of his researches."

There is reason to believe that at least twenty-one of the plates were ready, and that the rough copy of much of his manuscript was written, but that, the support he solicited not being forthcoming, the idea of publishing had to be abandoned (see *Trans. Devon. assoc.*, iii. 198–201).

In 1840 Mr. R. A. C. Austen, F.G.S. (now Godwin-Austen), read to the Geological society of London a paper on the bone-caves of Devonshire, which, with some amplifications, was incorporated in his memoir on the geology of the south-east of Devonshire, printed in the transactions of the society in 1842 (2d ser. vi. 433–489). Speaking of his own researches in Kent's Cavern, he said, "Human remains, and works of art, such as arrow-heads and knives of flint, occur in all parts of the cave, and throughout the entire thickness of the clay; and no distinction founded on condition, distribution, or relative position, can be observed whereby the human can be separated from the other reliquiae" (*Ibid.*, p. 444).

He added, "My own researches were constantly conducted in parts of the cave which had never been disturbed, and in every instance the bones were procured from beneath a thick covering of stalagmite. So far, then, the bones and works of man must have been introduced into the cave before the flooring of stalagmite had been formed" (*Ibid.*, p. 446).

Though these important and emphatic statements were so fortunate as to be committed to the safe keeping of print with but little delay, and under the most favorable circumstances, they appear neither to have excited any interest, nor, indeed, to have received much, if any, attention.

In 1846 the Torquay natural history society appointed a committee, consisting of Dr. Battersby, Mr. Vivian, and myself, — all tolerably familiar with the statements of Mr. MacEnery and Mr. Austen, — to make a few diggings in Kent's Cavern for the purpose of obtaining specimens for their museum. The work, though more or less desultory and unsystematic, was by no means carelessly done; and the committee were unanimously and perfectly satisfied that the objects they met with had been deposited at the same time as the matrix in which they were inhumed. At the close of their investigation they drew up a report, which was printed in the Torquay directory for Nov. 6, 1846 (see *Trans. Devon. assoc.*, x. 162). Its substance, embodied in a paper by Mr. Vivian, was read to the Geological society of London on May 12, 1847, as well as to the British association in the succeeding June; and the following abstract was printed in the Report of the association for that year (p. 73): —

"The important point that we have established is, that relics of human art are found *beneath* the unbroken floor of stalagmite. After taking every precaution by sweeping the surface, and examining most minutely whether there were any traces of the floor having been previously disturbed, we broke through the solid stalagmite in three different parts of the cavern, and in each instance found flint knives. . . . In the spot where the most highly finished specimen was found, the passage was so low that it was extremely difficult, with quarrymen's tools and good workmen, to break through the crust; and the supposition that it had been previously disturbed is impossible."

It will be borne in mind that the same paper was read the month before to the Geological society. The council of that body, being apparently unprepared to print in their *Quarterly journal* the statements it contained, contented themselves with the following notice, given here in its entirety (*Op. cit.*, iii. 353): —

"'On Kent's Cavern, near Torquay,' by Mr. Edward Vivian. — In this paper an account was given of some recent researches in that cavern by a committee of the Torquay natural history society, during which the bones of various extinct species of animals were found in several situations."

It will be observed that the 'flint knives' were utterly ignored, — a fact rendered the more significant by the following announcement on the wrapper of the journal: "The editor of the *Quarterly journal* is directed to make it known to the public that the authors alone are responsible for the facts and opinions contained in their respective papers."

Such, briefly, were the principal researches in Kent's Cavern, at intervals from 1825 to 1847. Their reception was by no means encouraging: Mr. MacEnery, after incurring very considerable expense, was under the necessity of abandoning the intention of publishing his 'Cavern researches;' Mr. Austen's paper, though printed unabridged, was given to an apathetic, unbelieving world, and was apparently without effect; and Mr. Vivian's paper, virtually the report by a committee of which he was a member, was cut down to four lines of a harmless, unexciting character.

For some years nothing occurred to break the quietude, which, but for an unexpected discovery on the southern shore of Torbay, would probably have remained to this day.

Early in 1858 the workmen engaged in a limestone-quarry on Windmill Hill, overhanging the fishing town of Brixham in South Devon, broke unexpectedly a hole through what proved to be the roof of an unknown and unsuspected cavern. I visited it very soon after the discovery, and secured to myself the refusal of a lease, to include the right of exploration. As the story of this cavern has been told at some length elsewhere (see *Phil. trans.*, clxiii. 471–572; or *Trans. Devon. assoc.*, vi. 775–856), it will here suffice to say, that at the instance of the late Dr. H. Falconer, the eminent paleontologist, the subject was taken up very cordially by the Royal and geological societies of London, a committee was appointed by the latter body, the exploration was placed under the superintendence of Mr. (now Professor) Prestwich and myself, and, being the only resident member of the committee, the actual superintendence fell of necessity to me.

The following facts connected with this cavern were, no doubt, influential in leading to the decision to have it explored: —

1. It was a virgin cave which had been hermetically sealed during an incalculably long period, the last previous event in its history being the introduction of a reindeer antler, found attached to the upper surface of the stalagmitic floor. It was therefore free from the objection, urged sometimes against Kent's Cavern, that having been known from time immemorial, and up to 1825 always open to all comers, it had perhaps been ransacked again and again.

2. It was believed, and it proved, to be a comparatively very small cavern; so that its complete exploration was not likely to require a large expenditure of time or of money.

It will be seen that the exploration was placed under circumstances much more likely to command attention than any of those which had preceded it. It was to be carried on under the auspices of the Royal and Geological societies by a committee consisting of Mr S. H. Beckles, Mr. G. Busk, Rev. R. Everest, Dr. H. Falconer, Mr. Godwin-Austen, Sir C. Lyell, Professor Owen, Dr. J. Percy, Mr. J. Prestwich, Professor (now Sir A. C.) Ramsay, and myself, — all fellows of the Geological society, and almost all of them of the Royal society also.

It was impossible not to feel, however, that the mode of exploration must be such as would not merely satisfy those actually engaged in the work, but such as would command for the results which might be obtained the acceptance of the scientific world generally. Hence I resolved to have nothing whatever to do with 'trial pits' here and there, or with shafts to be sunk in selected places, but first to examine and remove the stalagmite floor, then the entire bed immediately below (if not of inconvenient depth), horizontally throughout the entire length of the cavern, or so far as practicable; this accomplished, to proceed in like manner with the next lower bed; and so on until all the deposits had been removed.

This method, uniformly followed, was preferable to any other, because it would reveal the general stratigraphical order of the deposits, with the amount and direction of such 'dip' as they might have, as well as any variations in the thickness of the beds; it would afford the only chance of securing all the fossils, and of thus ascertaining, not only the different kinds of animals represented in the cave, but also the ratios which the numbers of individuals of the various species bore to one another, as well as all peculiar or noteworthy collocations; it would disclose the extent, character, and general features of the cavern itself; it was undoubtedly the least expensive mode of exploration; and it would render it almost impossible to refer bones, or indications of human existence, to wrong beds, depths, or associations.

The work was begun in July, 1858, and closed at the end of twelve months, when the cavern had practically been completely emptied. An official report was printed in the *Philosophical transactions* for 1873, and all the specimens have been handed over to the British museum.

The paper on the subject mentioned at the beginning of this address was read in September, 1858, during the meeting of the association at Leeds, when I had the pleasure of stating that eight flint tools had already been found in various parts of the cavern, all of them inosculating with bones of mammalia, at depths varying from nine to forty-two inches in the cave-earth, on which lay a sheet of stalagmite from three to eight inches thick, and having *within* it and *on* it relics of lion, hyena, bear, mammoth, rhinoceros, and reindeer.

It soon became obvious that the geological apathy previously spoken of had been rather apparent than real. In fact, geologists were found to have been not so much disinclined to entertain the question of human antiquity as to doubt the trustworthiness of the evidence which had previously been offered to them on the subject. It was felt, moreover, that the Brixham evidence made it worth while, and indeed a duty, to re-examine that from Kent's Cavern, as well as that said to have been met with in river-deposits in the valley of the Somme and elsewhere.

The first-fruits, I believe, of this awakening, was a paper by Mr. Prestwich, read to the Royal society, May 26, 1859, on the occurrence of flint implements, associated with the remains of animals of extinct species in beds of a late geological period, — in France at Amiens and Abbeville, and in England at Hoxne (*Phil. trans.* for 1860, pp. 277–317). This paper contains explicit evidence that Brixham Cavern had had no small share in disposing its author to undertake the investigation, which added to his own great reputation, and rescued M. Boucher de Perthes from undeserved neglect. "It was not," says Mr. Prestwich, "until I had myself witnessed the conditions under which these flint implements had been found at Brixham, that I became fully impressed with the validity of the doubts thrown upon the previously prevailing opinions with respect to such remains in caves" (*Op. cit.*, 280).

Sir C. Lyell, too, in his address to the geological section of the British association, at Aberdeen, in September, 1859, said, "The facts recently brought to light during the systematic investigation, as reported on by Dr. Falconer, of the Brixham Cave, must, I think, have prepared you to admit that scepticism in regard to the cave evidence in favor of the antiquity of man had previously been pushed to an extreme" (*Report Brit. assoc.*, 1859, *trans. sects.*, p. 93).

It is probably unnecessary to quote further to show how very large a share the exploration at Brixham had in impressing the scientific world generally with the value and importance of the geological evidence of man's antiquity. That impression, begun, as we have seen, in 1858, has not only lasted to the present day, but has probably not yet culminated. It has produced numerous volumes, crowds of papers, countless articles in reviews and magazines, in various countries; and perhaps, in order to show how very popular the subject became almost immediately, it is only necessary to state that Sir C. Lyell's great work on the 'Antiquity of man' was published in February, 1863; the second edition appeared in the following April; and the third followed in the succeeding November, — three editions of a bulky scientific work in less than ten months! A fourth edition was published in May, 1873.

Few, it may be presumed, can now doubt that those who before 1858 believed that our fathers had under-estimated human antiquity, and fought for their belief, have at length obtained a victory. Nevertheless, every anthropologist has doubtless, from time to time,

"Heard the distant and random gun
That the foe was sullenly firing."

The 'foe,' to speak metaphorically, seems to consist of very irregular forces, occasionally unfair but never dangerous, sometimes very amusing, and frequently but badly armed, or without *any* real armor. The Spartan law which fined a citizen heavily for going into battle unarmed was probably a very wise one.

For example, and dropping a metaphor, a pamphlet published in 1877 contains the following passage: "With regard to all these supposed flint implements and spear- and arrow-heads found in various places, it may be well to mention here the frank confession of Dr. Carpenter. He has told us from the presidential chair of the Royal academy that 'no logical proof can be adduced that the peculiar shapes of these flints were given them by human hands'" (see 'Is the book wrong? a question for sceptics,' by Hely H. A. Smith, p. 26). The words ascribed to Dr. Carpenter are put within inverted commas, and are the whole of the quotation from him. I was a good deal mystified on first reading them; for while it seemed likely that the president spoken of was the well-known member of this association, Dr. W. B. Carpenter, it was difficult to account for his being in the presidential chair of the Royal academy, and not easy to understand what the Royal academy had to do with flint implements. A little search, however, showed that the address which Dr. W. B. Carpenter delivered in 1872 from the presidential chair of, not the Royal academy, but the British association, contained the actual words quoted, followed immediately by others which the author of the pamphlet found it inconvenient to include in his quotation. Dr. Carpenter, speaking of 'common sense,' referred, by way of illustration, to the 'flint implements' of the Abbeville and Amiens gravel-beds, and remarked, "No logical proof can be adduced that the peculiar shapes of these flints were given to them by human hands; but does any unprejudiced person now doubt it?" (*Report Brit. assoc.*, 1872, p. lxxv.) Dr. Carpenter, after some further remarks on the 'flint implements,' concluded his paragraph respecting them with the following words: "Thus what was in the first instance a matter of discussion, has now become one of those 'self-evident' propositions which claim the unhesitating assent of all whose opinion on the subject is entitled to the least weight."

It cannot be doubted, that, taken in its entirety (that is to say, taken as every lover of truth and fairness should and would take it), Dr. Carpenter's paragraph would produce on the mind of the reader a very different effect from that likely, and no doubt intended, to be produced by the mutilated version of it given in the pamphlet.

A second edition of the pamphlet has been given to the world. Dr. Carpenter is still in the presidential chair of the Royal academy, and the quotation from his address is as conveniently short as before.

It would be easy to bring together a large number of similar modes of 'defending the cause of truth,' to use the words of the pamphlet just noticed; but space and time forbid.

I cannot, however, forego the pleasure of introducing the following recent and probably novel explanation of cavern phenomena. In 1882 my attention was directed to two articles by one and the same writer, on 'Bone-cave phenomena.' The writer's theme was professedly the Victoria Cave, near Settle, Yorkshire, which he says was an old Roman lead-mine; but his remarks are intended to apply to bone-caves in general. He takes a very early opportunity, in the second article, of stating that "we shall have to take care to distinguish between what is truly indicated in the 'science' view from what are purely imaginary exaggerations of its natural and historical phenomena;" and he no doubt believes that he has taken this care.

"We have now," he says, "to present our own view of the Victoria Cave and the phenomena connected with it, premising that a great many of the old mines in Europe were opened by Phoenician colonists and metal-workers a thousand years before the Romans had set foot in Britain, which accounts for the various floors of stalagmite found in most caves, and also for the variety of groups of bones embedded in them. The animals represented by them, when living, were not running wild about the hills, devouring each other, as science men suppose, but the useful auxiliaries and trained drudges of the miners in their work. Some of them, as the bear, had simply been hunted, and used for food; and others of a fierce character, as the hyena, to frighten and keep in awe the native Britons. The larger species of mammalia, as the elephant, the rhinoceros, and hippopotamus, and beasts foreign to the country, the Romans, no less than the Phoenicians, had every facility in bringing with them in their ships of commerce from Carthage, or other of the African ports. These, with the native horse, ox, and stag, which are always found in larger numbers in the caves than the remains of foreign animals, all worked peacefully together in the various operations of the mines. . . . The hippopotamus, although amphibious, is a grand beast for heavy work, such as mining, quarrying, or road-making; and his keeper would take care that he was comfortably lodged in a tank of water during the night. . . . The phenomena of the Victoria Cave lead-mine differ in no material respect from those of hundreds of others, whether of lead, copper, silver, or iron, worked in Roman and pre-Roman times in all parts of Europe. Its tunnels have all been regularly quarried and mined, *not by ancient seas*, but by the hands of historic man. Double openings have been made in every case for convenient ingress and egress during the process of excavation. Its roadways had been levelled, and holes made up with breccia, gravel, sand, and bones of beasts that had succumbed to toil, on which sledges, trolleys, and wagons could glide or run. . . . Near the entrance inside Victoria Cave were found the usual beds of charcoal, and the hearths for refining the metal; while close by, on the hillside, may still be seen the old kilns in which the men 'roasted' the metallic ores, and burned lime."

Should any one be disposed to ascribe these articles to some master of the art of joking, it need only be replied that they appeared in a religious journal (*The champion of the faith against current infidelity* for April 20 and May 11, 1882, vol. i. pp. 5 and 26), with the writer's name appended, and that I have reason to believe they were written seriously and in earnest.

It has been already intimated that Brixham Cavern has secured a somewhat prominent place in literature; and it can scarcely be needful to add that some of the printed statements respecting it are not quite correct. The following instances of inaccuracy may be taken as samples: —

The late Professor Ansted, describing Brixham Cavern in 1861, said, "In the middle of the cavern, under stalagmite itself, and actually entangled with an antler of a reindeer and the bones of the great cavern-bear, were found rude sculptured flints, such as are known to have been used by savages in most parts of the world" ('Geological gossip,' p. 209).

To be 'entangled' with one another, the antler, the bones of the cave-bear, and the flints, must have been all lying together. As a matter of fact, however, the antler was *on* the upper surface of the sheet of stalagmite, while all the relics of the cave-bear, and all the flints, were in detrital beds below that sheet. Again: the flints nearest the bear's bones in question were two in number: they were twelve feet south of the bones, and fifteen inches less deep in the bed. There was no approach to entanglement.

Should it be suggested that it is scarcely necessary to correct errors on scientific questions in works like 'Geological gossip,' professedly popular and intended for the million, I should venture to express the opinion that the strictest accuracy is specially required in such books, as the great majority of their readers are entirely at the mercy of the compilers. Those who read scientific books of a higher class are much more capable of taking care of themselves.

Professor Ansted's slip found its way into a scientific journal, where it was made the basis of a speculation (see *Geologist*, 1861, p. 246).

The most recent noteworthy inaccuracies connected with this famous cavern are, so far as I am aware, two in the English edition of Prof. N. Joly's 'Man before metals' (1883).

According to the first, "an entire left hind-leg of Ursus spelaeus was found lying above the incrustation of stalagmite which covered the bones of other extinct species and the carved flints" (p. 52).

It is only necessary, in reply to this, to repeat what has been already stated: all the bones of cave-bear found in the cavern were in beds *below* the stalagmite.

The following quotation from the same work contains the second inaccuracy, or, more correctly, group of inaccuracies, mentioned above: "We may mention, among others, the cave at Brixham, where, associated with fragments of rude pottery, and bones of extinct species, heaps of oyster-shells and other salt-water mollusks occur, as well as fish-bones of the genus Scarus" (p. 104).

I am afraid there is no way of dealing with this paragraph except that of meeting all its statements with unqualified denials. In short, Brixham Windmill-hill Cavern contained no pottery of any kind whatever, not a single oyster-shell, nor even a solitary bone of any species of fish. One common limpet-shell was the only relic of a marine organism met with in the cavern.

As already intimated, the result of the researches at Brixham quickened a desire to re-examine the Kent's Cavern evidence; and this received a considerable stimulus from the publication of Sir C. Lyell's 'Antiquity of man' in 1863. Having in the mean time made a careful survey of the cavern, and ascertained that there was a very large area in which the deposits were certainly intact, to say nothing of unsuspected branches which in all probability would be discovered during a thorough and systematic exploration, I had arrived at the conclusion, that, taking the cavern at its known dimensions merely, the cost of an investigation as complete as that at Brixham would not be less than £1,000.

Early in 1864 I suggested to Sir C. Lyell that an application should be made to the British association, during the meeting to be held at Bath that year, for the appointment of a committee, with a grant of money, to make an exploration of Kent's Cavern; and it was decided that I should take the necessary steps in the matter. The proposal being cordially received by the committee of the Geological section, and well supported in the committee of recommendations, a committee — consisting of Sir C. Lyell, Mr. J. Evans, Mr. (now Sir) J. Lubbock, Prof. J. Phillips, Mr. E. Vivian, and myself (honorable secretary and reporter) — was appointed, with £100 placed at its disposal. Mr. G. Busk was added to the committee in 1866, Mr. W. Boyd Dawkins in 1868, Mr. W. Ayshford Sanford in 1869, and Mr. J. E. Lee in 1873. The late Sir L. Palk (afterwards Lord Haldon), the proprietor, placed the cavern entirely under the control of the committee during the continuance of the work. The investigation was begun on March 28, 1865, and continued without intermission to June 19, 1880, the committee being annually re-appointed, with fresh grants of money, which in the aggregate amounted to £1,900, besides £63 received from various private sources.

The mode of exploration was essentially the same as that followed at Windmill Hill, Brixham; but as Kent's Cavern, instead of being a series of narrow galleries, contained a considerable number of capacious chambers, and as the aim of the explorers was to ascertain not merely what objects the deposits contained, but their exact position, their distribution, their condition, their collocation, and their relative abundance, the details had to be considerably more elaborate, while they remained so perfectly simple that the workmen had not the least difficulty in carrying them out, under my daily superintendence. The process being fully described in the First annual report by the committee (see *Report Brit. assoc.*, 1865, pp. 19, 20), it is unnecessary to repeat it here.

Mr. Godwin-Austen, while agreeing with Mr. MacEnery that flint implements occurred under the stalagmite, contended that they were found throughout the entire thickness of the cave-earth. MacEnery, on the other hand, was of opinion that in most cases their situation was intermediate between the bottom of the stalagmite and the upper surface of the cave-earth; and while admitting that occasionally, though rarely, they had been met with somewhat lower, he stated that the greatest depth to which he had been able to trace them was not more than a few inches below the surface of the cave-earth (*Trans. Devon. assoc.*, iii. 326, 327). The committee soon found themselves in a position to confirm Mr. Godwin-Austen's statement, and to say with him that "no distinction founded on condition, distribution, or relative position, can be observed whereby the human can be separated from the other reliquiae" (*Trans. geol. soc.*, 2d ser. vi. 444).

Mr. MacEnery's 'Plate F' contains seven figures of three remarkable canine teeth, and the following statement respecting them: "Teeth of Ursus cultridens, found in the cave of Kent's Hole, near Torquay, Devon, by Rev. Mr. MacEnery, January, 1826, in Diluvial Mud mix'd with Teeth and Gnaw'd Bones of Rhinoceros, Elephant, Horse, Ox, Elk, and Deer, with Teeth and Bones of Hyaenas, Bears, Wolves, Foxes, etc."

It is worthy of note, that no other plate in the entire series names the date on which the specimens were found, or the mammals with whose remains they were commingled. This arose probably from the fact, well known to MacEnery, that no such specimens had been found elsewhere in Britain; and possibly also to emphasize the statements in his text, should any doubt be thrown on his discovery.

It is, no doubt, unnecessary to say here that the teeth belonged to a large species of carnivore, to which, in 1846, Professor Owen gave the name of Machairodus latidens. MacEnery states that the total number of teeth he found were five upper canines and one incisor, and the six museums in which they are now lodged are well known.

A considerable amount of scepticism existed for many years in some minds, as to whether the relics just mentioned were really found in Kent's Cavern, it being contended, that, from its zoölogical affinities, Machairodus latidens must have belonged to an earlier fauna than that represented by the ordinary cave-mammals; and various hypotheses were invented to explain away the difficulty, most of them, at least, being more ingenious than ingenuous. Be this as it may, it was naturally hoped that the re-exploration of the cavern would set the question at rest forever; and it was not without a feeling of disappointment that I had to write seven successive annual reports without being able to announce the discovery of a single relic of Machairodus. Indeed, the greater part of the eighth report was written, with no better prospect, when, while engaged in washing a 'find' met with on July 29, 1872, I found that it consisted of a well-marked incisor of Machairodus latidens, with a left ramus of lower jaw of a bear, in which was one molar tooth. They were lying together in the first or uppermost foot-level of cave-earth, having over it a continuous sheet of granular stalagmite 2.5 feet thick. There was no longer any doubt of MacEnery's accuracy; no doubt that Machairodus latidens was a member of the cave-earth fauna, whatever the zoölogical affinities might say to the contrary; nor was there any doubt that man and Machairodus were contemporaries in Devonshire.

I cannot pass from this case without directing attention to its bearing on negative evidence. Had the exploration ceased on July 28, 1872, — the day before the discovery, — those who had always declined to believe that Machairodus had ever been found in the cavern would have been able to urge, as an additional and apparently conclusive argument, that the consecutive, systematic, and careful daily labor of seven years and four months had failed to show that their scepticism was unwarranted. Nay, more: had the incisor been overlooked, — and, being but a small object, this might very easily have occurred, — they might finally have said '15.25 years' labor;' for, so far as is known, no other relic of the species was met with during the entire investigation. In all probability, had either of these by no means improbable hypotheses occurred, geologists and paleontologists generally would have joined the sceptics; MacEnery's reputation would have been held in very light esteem, and, to say the least, his researches regarded with suspicion.

When its exploration began, and for some time after, the committee had no reason to believe or to suspect that the cavern contained any thing older than the cave-earth: but, at the end of five months, facts pointing apparently to earlier deposits began to present themselves; and, at intervals more or less protracted, additional phenomena, requiring apparently the same interpretation, were observed and recorded. But it was not until the end of three full years that a vertical section was cut, showing in undisturbed and clear succession, not only the cave-earth with the granular stalagmite lying on it, but, under and supporting the cave-earth, another, thicker and continuous, sheet of stalagmite (appropriately termed crystalline), and below this, again, an older detrital accumulation, known as the breccia, made up of materials utterly unlike those of the cave-earth.

The breccia was just as rich as the cave-earth in osseous remains, but the lists of species represented by the two deposits were very different. It will be sufficient to state here, that while remains of the hyena prevailed numerically very far above those of any other mammal in the cave-earth, and while his presence there was also attested by his teeth-marks on a vast number of bones; by lower jaws (including those of his own kith and kin), of which he had eaten off the lower borders as well as the condyles; by long bones broken obliquely, just as hyenas of the present day break them; and by surprising quantities of his coprolites, — there was not a single indication of any kind of his presence in the breccia, where the crowd of bones and teeth belonged almost entirely to bears.

No trace of the existence of man was found in the breccia until March, 1869, — that is, about twelve months after the discovery of the deposit itself, — when a flint flake was met with in the third foot-level, and was believed not only to be a tool, but to bear evidence of having been used as such (see *Report Brit. assoc.*, 1869, pp 201, 202). Two massive flint implements were discovered in the same deposit in May, 1872; and at various subsequent times other tools were found, until, at the close of the exploration, the breccia had yielded upwards of seventy implements of flint and chert.

While all the stone tools of both the cave-earth and the breccia were paleolithic, and were found inosculating with remains of extinct mammals, a mere inspection shows that they belong to two distinct categories. Those found in the breccia — that is, the more ancient series — were formed by chipping a flint nodule or pebble into a tool; while those from the cave-earth, the less ancient series, were fashioned by first detatching a suitable flake from the nodule or pebble, and then trimming the flake, not the nodule, into a tool.

It must be unnecessary to say that the making of nodule-tools necessitated the production of flakes and chips, some of which were no doubt utilized. Such flakes, however, must be regarded as accidents, and not the final objects the workers had in view.

It is worthy of remark, that in one part of the cavern, upwards of a hundred and thirty feet in length, the excavation was carried to a depth of nine feet, instead of the usual four feet, below the bottom of the stalagmite; and that, while no bone of any kind occurred in the breccia below the seventh foot-level, three fine flint nodule-tools were found in the eighth, and several flint chips in the ninth or lowest foot-level.

It may be added that the same fact presented itself in the lowest or corresponding bed in Brixham Windmill-hill Cavern. In short, in each of the two famous Devonshire caverns the archeological zone reached a lower level than the paleontological.

That the breccia is of higher antiquity than the cave-earth, is proved by the unquestionable evidence of clear, undisturbed superposition; that they represent two distinct chapters and eras in the cavern history, is shown by the decided dissimilarity of the materials composing them, the marked difference in the osseous remains they contained, and the strongly contrasted characters of the stone implements they yielded; and that they were separated by a wide interval of time, may be safely inferred from the thickness of the bed of stalagmite between them.

It is probable, however, that the fact most significant of time and physical change is the presence of the hyena in the cave-earth or less ancient, but not in the breccia or more ancient, of the two deposits. I called attention to this fact in a paper read to this department ten years ago (see *Report Brit. assoc.*, 1873, pp. 209–214), and at greater length elsewhere in 1875 (see *Trans. Plym. inst.*, v. 360–375). Bearing in mind the cave-haunting habits of the hyena, the great preponderance of his remains in the cave-earth, and their absence in the breccia, it seems impossible to avoid the conclusion that he was not an occupant of Britain during the earlier period.

The acceptance of this conclusion, however, necessitates the belief, 1°, that man was resident in Britain long before the hyena was; 2°, that it was possible for the hyena to reach Britain between the deposition of the breccia and the deposition of the cave-earth; in other words, that Britain was a part of the continent during this interval.

Sir C. Lyell, it will be remembered, recognized the following geographical changes within the British area between the newer pliocene and historical times (see 'Antiquity of man,' edition 1873, pp. 331, 332): —

Firstly, A pre-glacial continental period, towards the close of which the Forest of Cromer flourished, and the climate was somewhat milder than at present.

Secondly, A period of submergence, when the land north of the Thames and Bristol Channel, and that of Ireland, was reduced to an archipelago. This was a part of the glacial age, and icebergs floated in our waters.

Thirdly, A second continental period, when there were glaciers in the higher mountains of Scotland and Wales.

Fourthly, The breaking-up of the land through submergence, and a gradual change of temperature, resulting in the present geographical and climatal conditions.

It is obvious, that if, as I venture to think, the Kent's Cavern breccia was deposited during the first continental period, the list of mammalian remains found in it should not clash with the list of such remains from the Forest of Cromer, which, as we have just seen, flourished at that time. I called attention to these lists in 1874, pointing out, that, according to Professor Boyd Dawkins ('Cave-hunting,' p. 418), the forest-bed had at that time yielded twenty-six species of mammals, sixteen of them being extinct and ten recent; that both the breccia and the forest-bed had yielded remains of the cave-bear, but that in neither of them had any relic or trace of hyena been found. A monograph on the 'Vertebrata of the forest-bed series' was published in 1882 by Mr. E. T. Newton, F.G.S., who, including many additional species found somewhat recently, but eliminating all those about which there was any uncertainty, said, "We still have forty-nine species left, of which thirty are still living and nineteen are extinct" (p. 135). Though the number of the species has thus been almost doubled, and the presence of the cave-bear remains undoubted, it continues to be the fact that no trace of the hyena has been found in the forest-bed, and no suspicion exists as to his probable presence amongst the eliminated uncertain species.

It should be added, that no relic or indication of hyena was met with in the 'fourth bed' of Brixham Windmill-hill Cavern, believed to be the equivalent of the Kent's Hole breccia.

I am not unmindful of the fact that my evidence is negative only, and that raising a structure on it may be building on a sandy foundation. Nevertheless, it appears to me, as it did ten years ago, strong enough to bear the following inferences: —

1. That the hyena did not reach Britain until its last continental period.

2. That the men who made the paleolithic nodule-tools found in the oldest known deposit in Kent's Cavern arrived during the previous great submergence, or, what is more probable, — indeed, what alone seems possible, unless they were navigators, — during the first continental period. In short, I have little or no doubt that the earliest Devonians we have sighted were either of glacial, or, more probably, of pre-glacial age.

It cannot be necessary to add, that while the discovery of remains of hyena in the forest-bed of Cromer, or any other contemporary deposit, would be utterly fatal to my argument, it would leave intact all other evidence in support of the doctrine of British glacial or pre-glacial man.

Some of my friends accepted the foregoing inferences in 1873; while others, whose judgment I value, declined them. Since that date no adverse fact or thought has presented itself to me; but through the researches and discoveries of others in comparatively distant parts of our island, and especially in East Anglia, the belief in British pre-glacial man appears to have risen above the stage of ridicule, and to have a decided prospect of general scientific acceptance at no distant time.

I must, before closing, devote a few words to a class of workers who are 'more plague than profit.'

The exuberant enthusiasm of some would-be pioneers in the question of human antiquity results occasionally in supposed 'discoveries,' having an amusing side; and not unfrequently some of the pioneers, though utter strangers, are so good as to send me descriptions of their 'finds,' and of their views respecting them. The following case may be taken as a sample: in 1881 a gentleman of whom I had never heard wrote, stating that he was one of those who felt deeply interested in the antiquity of man, and that he had read all the books he could command on the subject. He was aware that it had been said by one paleontologist to be "unreasonable to suppose that man had lived during the eocene and miocene periods," but he had an indistinct recollection that another eminent man had somewhere said that "man had probably existed in England during a tropical carboniferous flora and fauna." He then went on to say, "I have got that which I cannot but look upon as a fossil human skull. I have endeavored to examine it from every conceivable stand-point, and it seems to stand the test. The angles seem perfect; the contour, the same, but smaller in size than the average human head: but that, in my opinion, is only what should be expected, if we assume that man lived during the carboniferous period, in spite of what Herodotus says about the body of Orestes." Finally he requested to be allowed to send me the specimen. On its arrival, it proved, of course, to be merely a stone; and nothing but a strong 'unscientific use of the imagination' could lead any one to believe that it had ever been a skull, human or infrahuman.

It may be added, that a few years ago a gentleman brought me what he called, and believed to be, 'three human skulls, and as many elephants' teeth,' found from time to time during his researches in a limestone-quarry. They proved to be nothing more than six oddly-shaped lumps of Devonian limestone.

So far as Britain is concerned, cave-hunting is a science of Devonshire birth. The limestone-caverns of Oreston, near Plymouth, were examined with some care, in the interests of paleontology, as early as 1816, and subsequently as they were successively discovered. The two most famous caverns of the same county — one on the northern, the other on the southern, shore of Torbay — have been anthropological as well as paleontological studies, and, as we have seen, have had the lion's share in enlarging our estimate of human antiquity. The researches have, no doubt, absorbed a great amount of time and labor, and demanded the exercise of much care and patience; but they have been replete with interest of a high order, which would be greatly enhanced if I could feel sure that your time has not been wasted, nor your patience exhausted, in listening to this address respecting them.

LETTERS TO THE EDITOR.

Tree-growth.

THE 'influence of winds upon tree-growth,' causing the asymmetry to which Mr. Kennedy calls attention in SCIENCE for Oct. 5, is noticeable to a remarkable degree among conifers in the mountains of the western half of the United States. The stunted, ground-hugging evergreens, which advance a little way above the limit of ordinary timber-growth on lofty mountains, are pressed to the earth by the steady gales as much as by overbearing snows, if not more. Evidence of this is found in the fact, that, where a cleft or little hollow occurs at or in advance of timber-line, the trees will stand straight and shapely within it as high as its rim (although in such nooks the snows lie longest and most deeply), above which they will be deformed, or unable to grow at all. This bending of the trees, the whole skirt of a forest, away from the edge of a precipice, or on a hilltop over which the wind sucks through the funnel of a cañon, is so common as to be seen every day by one travelling through the Rockies or the Sierra Nevada. It is particularly true in the Sierra San Joan, where the radiation of the vast adjacent sage-plains produces an extraordinary suction upward, toward the chilly crests of that lofty range. I remember noticing it nowhere more strongly than on the coast of Sonoma county, Cal., swept by a constant indraught from the Pacific.

This was the locality of my article in *Harper's magazine* for January, 1883, styled 'In a redwood logging-camp.' In that article (p. 194), after speaking of the stiff, erect trunks of the Sequoia, as seen inland, I say, "In windy places, like the exposed sea-front, all the boughs are twisted into a single plane landward, and great picturesqueness results." As you look at these trees from a distance, you cannot resist the impression (however quiet the sea and the air) that a furious gale is at that moment straining every branch to leeward, as a March day does the garments of pedestrians, or the flags of the shipping in a harbor. The seashore parks of Victoria or Vancouver, and of San Francisco, give other examples of this same appearance. A conspicuous instance of this same thing is to be seen in the Salinas valley, which extends for over a hundred miles southward from Monterey. There a high point of view shows that every tree and bush (save large clusters) in the whole valley leans toward the south-east (approximately), urged by the terrific wind that never ceases to rush up the long valley from the sea to the hills.

It is needless, however, to seek examples so far away. A line of evergreens along the Greenwich River, in eastern Connecticut, shows the asymmetry produced by wind very plainly; and the shore-trees all along Montauk Point, and the low islands on that coast, are bent away from the sea. On any ocean coast (or equally along the Great Lakes), on wide plains, or in any lofty mountain-range, according to my pretty wide observation in the United States, one might tell the course of the prevailing winds as accurately as fifty years of signal-service observation, by a glance at exposed trees, which, nurtured in steady gales, bend in age as their sapling twigs were inclined.

Snow is another factor to be considered in regarding the growth of trees in mountain regions. The flattened thickets of spruce just above timber-line, of the same species which, in sheltered spots no lower down, assumes an erect and lofty attitude, are matted close to the ground by long weight of snow, as well as bowed beneath fierce gales. Many and varied examples of its effect might be adduced; but I will refer to one only. On the road to the anthracite mine above Crested Butte, in the Elk Mountains of Colorado, you pass through a large grove of aspens, some eighteen inches or more in diameter, standing thickly on the hillside, at an elevation of about nine thousand feet. That region is famous for its deep snows, which might be inferred from the fact that every tree in this broad aspen-grove is bent far out of the vertical, many of them thirty or forty degrees, and all uniformly as to direction. The only explanation of this is the snow, which weights them down through so many months of the year. The sturdier trunks rise vertically in many cases, but their tops arch over almost in a semicircle; while the saplings are bowed nearly to the ground. In many parts of the mountains, great swaths lie open in the woods, and can never (or at least do not) become forested on account of snow-slides; while the opposition of wind and snow together are the only conceivable reasons why many bare plateaus are not tree-grown; that, for example, between the Lake Fork of the Gunnison and Cochetopa Creek.

Ernest Ingersoll.

New Haven, Oct. 10, 1883.

Standard railroad time.

Though the subject of standard and uniform railway time has for some years been under consideration by various scientific and practical bodies, it does not appear in any way to have been exhausted, even in its main features. Besides, a certain bias has shown itself in favor of the adoption of a series of certain hourly meridians, and thus keeping Greenwich minutes and seconds, when contrasted with the practicability of a more simple proposition. There is also a feature in the discussion of the subject which bears to have more light thrown upon it; namely, what necessary connection there is between the railway companies' uniform time and the mean local time of the people, or the time necessarily used in all transactions of common life. Directly or by implication, certain time-reformers evidently aim at a standard time, which shall be alike binding on railway traffic as well as on the business community; and to this great error much of the complexity of the subject is to be attributed, and it has directly retarded the much-needed reform in the time-management of our roads.

We say all ordinary business everywhere must forever be conducted on local mean solar time, the slight difference between apparent and mean time having produced no inconvenience; and we may rightly ask the railway companies to give in their time-tables for *public* use everywhere and always, the mean *local* time of the departure and of the arrival of trains. It is the departure from this almost self-evident statement, and the substitution and mixing-up in the time-tables of times referred to various local standards, which has in no small measure contributed to the confusion and perplexity of the present system. The people at large do not care to know by what time-system any railroad manages its trains, any more than they care what the steam-pressure is, or what is the number of the locomotive All the traveller is interested in is regularity and safety of travel: hence it was to be desired, that, whatever the standard or standards of time adopted, the companies would refrain from troubling him with a matter which only concerns their internal organization, or which is entirely administrative. We look upon the publication of the railway time-tables, by local time everywhere, as a *sine quâ non* for the satisfactory settlement of the time question, so far as the public at large is concerned; and it would seem equally plain that the best system for the administration of railroads would be the adoption of a uniform time, this time to be known only to the managers and employees of the roads.

We are informed in Science of Oct. 12, that the solution of the problem of standard railway time is near at hand, and probably has already been consummated by the adoption of four or more regions, each having uniform minutes and seconds of Greenwich time, but the local hour of the middle meridian. To have come down from several dozen of distinct time-systems to a very few and uniform ones, except as to the hour, is certainly a step forward, and, so far, gratifying; but why not adopt Greenwich time, pure and simple, and have absolute uniformity? Probably this will be felt before long. The counting of twenty-four hours to the day, in the place of twice twelve, and the obliteration from time-tables of the obnoxious A.M. and P.M. numbers, would seem to be generally acknowledged as an improvement and simplification, and perhaps can best be dealt with by adopting it at once, accompanied by a simple explanatory statement.

C. A. Schott.

Washington, Oct. 18, 1883.

PACKARD'S PHYLLOPOD CRUSTACEA.

A monograph of the phyllopod Crustacea of North America, with remarks on the order Phyllocarida. By A. S. Packard, Jun. Author's edition, extracted from the twelfth annual report of the U. S. geological and geographical survey. Washington, 1883. 298 p., 39 pl., map. 8°.

Although Professor Packard began publishing upon the Phyllopoda long ago, and has for several years been well known to be engaged upon a monograph of the North-American species, the bulk of the work just published, and the profusion of its illustrations, are a great surprise. It is the most extensive, and in many ways the most important, monographic contribution to American carcinology; and, however we may criticise the execution of the work, every student of the American fauna must feel grateful to the author for undertaking and accomplishing it.

The work is much more than a systematic monograph of North-American Phyllopoda, as the following table of contents will show: I. Classification of the living Phyllopoda, which includes the systematic description of the North-American species; II. Geological succession, including descriptions of the North-American fossil species; III. Geographical distribution; IV. Morphology and anatomy; V. Development, metamorphoses, and genealogy; VI. Miscellaneous notes on the reproductive habits of Branchipodidae, by Carl F. Gissler; VII. The order Phyllocarida, and its systematic position; VIII. Bibliography; Appendix, consisting of translations or abstracts by Gissler, of papers by C. T. von Siebold, on Artemia fertilis from Great Salt Lake, and on parthenogenesis in Artemia salina; and by Schmankewitsch, on the relation of Artemia salina to Artemia Muehlhausenii and to the genus Branchipus, and on the influence of external conditions of life upon the organization of animals. There is some confusion between the titles of the principal divisions, which are given above, and the table of contents in the work itself. Scarcely any of the titles are the same; and, in place of 'Miscellaneous notes on the reproductive habits of Branchipodidae,' we have, in the table of contents, 'Relation to their environment; habits,' — subjects nowhere treated under a separate heading; and all reference to the long appendix is omitted.

About a fourth of the entire work is devoted to the systematic account of the species and higher groups of Phyllopoda, regarded by Professor Packard as a sub-order of Branchiopoda, which is made to include Cladocera and Ostracoda also. The Phyllopoda are divided as follows into families and sub-families, which include the number of recognized North-American genera and species nearly as indicated: —

Limnadiidae:
 Limnetinae (1 genus, 4 species).
 Estheriinae (3 genera, 11 species).
Apodidae (2 genera, 9 species).
Branchipodidae:
 Branchipodinae (5 genera, 12 species).
 Thamnocephalinae (1 genus, 1 species).

All the groups are described; nearly all the species are figured, many of them very fully; and important notes on variability and habits are given for some of the species. Artemia gracilis is treated more at length than any other species, and is made to include all the described North-American species; but, in regard to its relation to the European A. salina, there is certainly confusion, as the following paragraphs show.

"Upon comparing our species with the European, it is difficult to find good differential characters, as the portions of the body where specific differences would be expected to occur are liable to considerable variation. Upon comparing a number of females from Great Salt Lake with a number of females of the maleless generation from Trieste, Austria, received from Professor Siebold, there are really no differences of importance. Our A. gracilis (Verrill's fertilis) is slighter, with a smaller head; and perhaps the second antennae are a little slighter in build; I see no essential difference in the form of the ovisac, while the shape of the legs, especially the sixth endite, is essentially the same" (p. 331).

"On comparing a number of Salt Lake females with individuals of the same sex of the European Artemia salina, our species was found to be undoubtedly specifically distinct; the Utah specimens are slenderer, smaller, and the sixth endite of all the feet considerably slenderer and longer in proportion than in A. salina. The ovisacs were of the same proportion but slenderer, and the head is slighter and smaller in our American species" (p. 333).

Different conclusions on neighboring pages, in regard to the specific identity of closely allied forms, might be accounted for in a careless author; but differences like these in statements of observation betray inexplicable carelessness.

In the chapter on geological succession, a table of the geological and geographical distribution of the known fossil species is given, and also a diagram indicating the geological history of the orders of Crustacea, the sub-orders of Branchiopoda, and the families of Phyllopoda. It is said that this diagram "may also serve as a genealogical tree, showing the probable origin of the main divisions of the Crustacea:" but the genealogical part of the diagram consists simply of dotted lines connecting the points of first appearance in geological history of the Branchipodidae, Apodidae, and Cladocera, with the point of appearance of the Limnadiidae in the Silurian; the common stem from this point with the Ostracoda in the upper Laurentian; and the branchiopod stem thus formed, and continued to a hypothetical Protonauplius in the lower Laurentian, with the points of appearance of the Malacostraca, Phyllocarida, and Cirripedia. On what conceivable theory of evolution this would represent a possible, much less the probable, origin of the main divisions of the Crustacea, it is hard to imagine, and was probably not seriously considered by the author himself; for it is far less like a probable genealogical tree than the diagram on p. 448, illustrating the relations of the Phyllocarida to other Crustacea.

In the chapter on morphology and anatomy, Professor Packard discusses at length the morphology of the regions of the body and the appendages of Arthropoda in general, and of the crustacean limb in particular, and gives some account of the anatomy of the phyllopods, but adds very little to our previous knowledge of the anatomy of the group. The morphological discussion is an interesting contribution to the subject, and, with the numerous figures with which it is illustrated, will prove very useful, although most of the new nomenclature proposed for the regions of the body and appendages is very objectionable. Professor Packard says, "For the primary regions of the head (*sic*), the only scientific terms as yet in use are those proposed by Prof. J. O. Westwood, in Bate and Westwood's History of British sessile-eyed Crustacea (vol. i. p. 3). These are *cephalon* for the head, *pereion* for the thorax, and *pleon* for the abdomen; while the thoracic feet are termed *pereiopoda*, and the abdominal legs *pleopoda;* the three terminal pairs being called *uropoda*. As the names applied to the thorax and abdomen have no especial morphological significance, the Greek περαιον, simply meaning ulterior, and πλεον, more, we would suggest that the head be termed the *cephalosome*, the cephalic segments, *cephalomeres*, and the cephalic appendages in general, *protopoda*, the term 'cephalopoda' being otherwise in use. The thorax of insects and of most Crustacea might be designated the *baenosome* (βαινω, to walk, locomotion), and the thoracic appendages, *baenopoda*, the segments being called *baenomeres;* while *urosome* might be applied to the abdomen, the abdominal segments being called *uromeres*. Westwood's term *uropoda* might be extended so as to include all the abdominal appendages." If mere names of parts are to be rejected, simply for want of 'morphological significance,' the language of the morphologist would soon become a meaningless jargon, to which it is near enough already; but, even as to 'morphological significance,' there appears to be little choice between the new and old terms. Bate, when first proposing the terms 'pereion'[1] and 'pleon,' expressly states that he derives the terms from περαιόω (*'to walk about'*) and πλέω (*navigo*). The proposed term 'protopoda' is quite as unfortunate as 'cephalopoda,' since 'protopodite' and 'protopod' are already in use for parts of crustacean appendages, the former even in the present work. The extension of the term 'uropoda' so as to make it synonymous with 'pleopoda' would also be unfortunate, since, as now employed, it is a very useful term to designate the modified caudal pleopoda, whether one, two, or three pairs.

In the chapter on development, metamorphoses, and genealogy, Professor Packard gives a short account of the nauplius form in Phyllopoda as an introduction to Dr. Gissler's interesting notes in the following chapter, and then briefly discusses the phylogeny of the group, in which he appears to find but one difficulty. He says, —

"The difficulty is (and this is a point apparently overlooked by Fritz Müller, Dohrn, Claus, and Balfour) to account for the origination of the phyllopods at all from any marine forms. The only explanation we can suggest, is that the phyllopods have arisen through Limnetis directly from some orginally marine cladocerous type like the marine forms now existing, such as Evadne. We imagine that when a permanent body of fresh water became established, as, for example, in perhaps early Silurian times, the marine forms carried into it in the egg-condition, possibly by birds or by high winds, hatched young, which, under favorable conditions, changed into Sida, Moina, and Daphnia-like forms."

Professor Packard appears to have overlooked the difficulty of the eggs of any marine cladocerous type of animals surviving a sudden transfer from salt to fresh water, and the

[1] According to either Bate's or Packard's derivation, this would be more properly written *peraeon*, as has sometimes been done, or even *pereon*.

absence of birds in the Silurian, which might well deter the boldest speculator from offering such an explanation; but when we consider that permanent bodies of fresh water were undoubtedly formed by the gradual freshening of bodies of salt water cut off from the ocean, and that such bodies of fresh water usually had outlets connecting them with the sea, it is not surprising that Fritz Müller, Dohrn, and others should overlook a difficulty which is no greater for Phyllopoda than for other groups of fresh-water animals.

In the chapter on his new order, Phyllocarida, and its systematic position, Professor Packard describes the anatomy and development of Nebalia, and discusses its fossil allies. The appendages of Nebalia bipes are described and fully figured, but on the internal anatomy very little that is new is given. The figures and text intended to elucidate the histology, like most of Professor Packard's similar work, leave much to be desired.

The bibliography consists of a hundred and thirty-eight titles, divided into four sections, — one for living and one for fossil Phyllopoda, and the same for Phyllocarida. The titles of many of the works referred to are omitted in the bibliography, which is evidently very incomplete; but its incompleteness is not so annoying as the entire want of system in its arrangement, and the frequency of typographical errors.

Typographical errors are very numerous in all parts of the work; and many of them cannot properly be charged to the proof-reader, who, however, ought to have corrected blunders like 'Yahresbericht' (several times) and 'zoogloical,' and the inexplicable punctuation of most of the bibliographical references in the systematic parts of the work. Errors due to careless writing or careless compiling are more common than purely typographical errors, and far more confusing. On p. 313 we have the following: "It is difficult to say whether this is a Limnadia or Estheria, as the description is too brief and inexact to enable us to determine the genus or species. It cannot be a Limnadia, and seems to approximate more closely to Estheria; though it cannot belong to that genus." On p. 335 it is said that 'Schmankevitch' found 'Branchinecta ferox (Fischer sp.)' transform by artificial means into Artemia; but in reality he found an Artemia change into a Branchinecta, or into what he considered a Branchipus. On p. 337, 'Labrador examples' are said to have been taken 'on the north side of Hamilton Inlet, Northern Greenland.' On pp. 313 and 314 the species of Estheriinae not recognizable are inserted between two species of Eulimnadia instead of at the end of the sub-family. Two paragraphs at the bottom of p. 349, under Streptocephalus Sealii, should have been placed under Chirocephalus Holmani, on p. 352. On pp. 356 to 358 the genus Leaia is inserted between two species of Estheria.

The plates, perhaps the most valuable part of the work, are nearly all lithographs from the establishment of Thomas Sinclair & son, and are apparently accurate representations of the original drawings. The general figures, mostly drawn by Emerton and Burgess, are excellent. The figures of details, drawn by the author, are not always so satisfactory: the figures of the appendages of Apus and Lepidurus, for example, are very rudely drawn, and badly arranged on the plates. Unfortunately, the amount of enlargement of scarcely any of the figures is given.

S. I. SMITH.

SIR WILLIAM LOGAN.

Life of Sir William E. Logan, Kt., LL.D., F.R.S., F.G.S., etc., first director of the Geological survey of Canada. By BERNARD J. HARRINGTON, B A., Ph D., professor of mining in McGill university. Montreal, *Dawson Bros*, 1883. With steel portrait and numerous woodcuts. 432 p. 8°.

A LIFE of Logan will be greeted by all geologists as a fit companion for those which have recently appeared of his English colleagues, Lyell and Murchison. What they did for Great Britain, he did for his native Canada, and even more. He solved the most complicated geological problems in vast areas where no white man had ever trod before him. He forced his way through trackless forests, making his own surveys and maps as he proceeded, and, in spite of such difficulties, not only discovered the structure of a greater part of his own country, but gave to the world a new series of formations. The work of Murchison and Sedgwick he completed by carrying order and succession beyond the Silurian and Cambrian, into that chaos of still older rocks, thus rendering the soil of his beloved Canada forever classic in geological annals.

The author of the present memoir has given us Sir William's history almost in his own words. By means of judicious extracts from his voluminous correspondence and journals, chronologically arranged, we are presented with a charming picture of the man, as well as the *savant*, all the more faithful because it is unconsciously given. Here we see portrayed an indomitable will, the keenest power of observation, as well as the coolest judgment in drawing conclusions, rare tact in managing his fellow-men, a ready sense of humor, combined with those subtler qualities of heart which make a man *beloved* wherever he may be. The author has rendered his work doubly attractive by making it sort of an unintentional autobiography.

Sir William Edmond Logan was born in Montreal, April 20, 1798, and remained at home until he was sent to the Edinburgh high school, in 1814. He studied at the high school and university of this place until 1817, when he entered upon a mercantile life in London, which he continued during the following fourteen years. In 1831 he was placed in charge of a copper company, near Swansea, in Wales, where he exhibited for the first time his geological proclivities. This company mined its own coal, and it was through this fact that he was led to his first really scientific investigations. He prepared a map of the South Wales coal-district with a degree of accuracy which had hardly before been equalled by any geological workers. This map attracted much attention from De la Beche, and other of England's most prominent geologists, and secured him influential friends who ever remained true to him.

In 1840 Logan returned to his native land, and spent over a year in studying the coal formation in New Brunswick and Pennsylvania. The results of his investigations relating to the origin of coal *in situ* were published soon after he returned to England. The subject of a government geological survey had been for some time under discussion in Canada, when, in 1841, £1,500 was appropriated for this purpose; and in the following year Logan received, upon the recommendation of his friends De la Beche, Murchison, Buckland, and Sedgwick, the appointment of director. During the seasons of 1843–44 he devoted his attention to studying the peninsula of Gaspé, where coal had been reported, and, in an incredibly short time, unravelled the geological complexities of a vast wilderness. The coal was not found, but its absence from the Silurian and Devonian rocks which compose that region was placed beyond a doubt.

But notwithstanding the energy with which Logan's work was carried on, and the success which attended it, his efforts to awaken in his countrymen an interest in geological pursuits were for a long time not appreciated. Years of doubt and anxiety followed the opening of the survey; and it was only through the indomitable will and consummate tact of its director that the opposition of a short-sighted government was finally overcome, and its permanent existence assured.

Although nothing was more foreign to Sir William's character than a taste for display, or a desire for fame, he fully appreciated the advantages to the survey and to Canada which must arise from having the results of his work widely known. Thus it was that he willingly undertook the charge of the Canadian exhibit at three world's fairs, — London in 1851 and 1862, and Paris in 1855, — and was more than repaid for his untiring exertions by the success which attended them. He saw, largely through his own efforts, an active interest in his native land awakened in Europe, the knowledge of her resources extended, and her industries and wealth thereby increased; while these practical results of his own work secured to him the encouragement of his countrymen, and honors poured fast upon him from all quarters. His appropriations were increased year by year; the best specialists were associated with him in different departments, such names as Hunt, Murray, and Billings, adding no little lustre to the survey's name; the field of work was extended over all of Canada that was accessible; and ample opportunity was given for the publication of scientific results.

Into the details of Sir William's special work we have here no time to enter: suffice it to say, that the sphere of his labors was very varied, as the list of his memoirs appended to the present work will show, his discoveries numerous and important, and all that he accomplished most thoroughly and accurately done. But the survey was always his especial care; and he may well have considered his life's work performed, when, at his resignation from the directorship in 1869, he could leave it upon a permanent footing, provided with every facility for future activity and usefulness. To the close of his life, his interest in its work never abated; and his last thoughts were devoted to completing some of his investigations begun as its director.

In August, 1874, Sir William once more went to England, and died the following June, at his sister's house in Wales. As a geologist, he will always be honored in the scientific world; while, as a man and as a friend, he will long be remembered by those who were never able to appreciate his work.

A very valuable paper on the history of the rocks of the Quebec group, by Principal Dawson of McGill college, forms a most welcome addition to this, of itself, so interesting book.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

The divisions in Saturn's rings. — Professor Kirkwood, in 1868, accounted for the great division in Saturn's rings by the commensurability of the period of a body revolving at that distance from Saturn with the periods of the six inner satellites. Dr. William Meyer of Geneva has investigated every possible combination of the commensurabilities of the revolution periods of the satellites, and finds six other places where a perturbing influence is exercised. The divisions most strongly marked seem to be at places where the commensurabilities are the closest, and all the satellites take part. A faint division should be found in the inner bright ring, according to Dr. Meyer. Prof. Holden has noted a distinct point at which the shading-off begins, in the position indicated by Meyer's theory, — a fact which seemed to have escaped Meyer's notice. — (*Observ.*, Sept., trans. from *Astr. nachr.*, 2,527, with additions.) M. McN. [306

Saturn. — Dr. William Meyer of Geneva gives a new determination of the orbits of six of Saturn's satellites, — Enceladus, Tethys, Dione, Rhea, Titan, and Iapetus. From each of these he has determined the mass of Saturn, the reciprocal value of the combined result being $M = 3,482.9 \pm 5.5$. The original observations are to appear in the *Mémoires de la société de physique de Genève* during the present year. — (*Astr. nachr.*, 2,528.) M. McN. [307

MATHEMATICS.

Functions of a complex variable. — In the present paper, entitled 'Applications of Fourier's theorem to the theory of the functions of a complex variable,' M. Harnack first shows in what manner the Fourier series are to be employed in the discovery of a rigid basis for the Cauchy-Riemann theorem concerning the development of functions of a complex variable. A generalization is also given of the fundamental hypothesis involved in the C.-R. theorem, as follows: if w is a function of $x + iy$, which over a simply connected plane region is everywhere continuous, and which 'in general' satisfies the differential equation, —

$$\frac{dw}{dx} + i\frac{dw}{dy} = 0,$$

then the function w is with its derivatives everywhere finite and continuous, and will possess no singular points. The term 'in general' (*im allgemeinen*) means that the points which do not satisfy the above differential equation, together with the points for which the partial derivatives $\frac{dw}{dx}$ and $\frac{dw}{dy}$ are indeterminate between finite or infinite limits, or are discontinuous, shall make up simply a discrete system of curves. In the second part of the paper, the author has gone very briefly into the subject of the representation of an analytical function, without singularities, in the interior of a circle by aid of Dirichlet's principle. — (*Math. ann.*, xxi.) T. C. [308

ENGINEERING.

Heavy engines and American railroad-tracks. — Mr. O. Chanute states that heavy 'consolidation' engines do not injure the track more than the lighter engines formerly did. Trains have been lengthened from 22 cars in 1874 to 38 in 1883; and the weights hauled, from 106 to 228 tons. By strengthening draw-heads, links, and pins, accidents from breaking apart of trains have been diminished, and the cost of haulage has been reduced from one cent to a half-cent per ton per mile. — (*Mechanics*, July 28.) R. H. T. [309

The British institution of mechanical engineers. — This society held its summer meeting in Belgium. It was received by the Association of engineers of Liége university, and visited the principal engineering establishments of the country. President Westmacott, in his opening address, called attention to the progress recently made in the rapid production of good articles of manufacture, and to the fact that speed and excellence of work are not incompatible where machinery is used. The materials must be of the best quality, however, the machines well proportioned, and all working parts well balanced and well fitted. He referred to Thorneycroft's experience with torpedo-boats, and called attention to the fact, that, at high speeds, the difficulties of lubrication and the jar observed at lower speeds disappear. In the speed of railway-trains, no advance has been lately made, and the maximum speeds remain at the figures of earlier years. Some economy has been obtained by the use of the crude products of the distillation of petroleum in the fireboxes of locomotives, this economy sometimes amounting to fifty per cent. Cotton-machinery has been speeded up, until the spindles which formerly made 5,000 revolutions are now making from 8,500 to 10,000, on fine American cotton. The increase in speed of woollen-machinery has not been great. In gunnery, the weight of gun and projectile have increased, in twenty-five years, from 5 tons and 66 pounds to 100 tons and 2,000 pounds. The shot has an initial energy of nearly 50,000 foot-tons. High speed is the direction of change in all departments of engineering. — (*Nature.*) R. H. T. [310

Hardening soft limestones with fluosilicates. — The application of alkaline silicates to the exterior of buildings, in order to prevent the deterioration of the stone, has not been attended with satisfactory results. H. L. Kessler proposes to use a solution of fluosilicates of bases whose oxides and carbonates are insoluble in a free state. When soft limestone is saturated with a concentrated solution of a fluosilicate of magnesium, aluminum, zinc, or lead, a very considerable degree of induration is soon reached, and the resulting products, except the liberated carbonic anhydride, are less soluble than the stone itself. No varnish is formed, and therefore no danger arises from expansion of frost beneath it. The process has resisted the severe tests of winter. Colors may be introduced satisfactorily. — (*Les mondes; Amer. arch.*, Sept. 1.) C. E. G. [311

CHEMISTRY.

(General, physical, and inorganic.)

The yellow and red plumbic oxides. — A study of the formation and properties of the two forms of plumbic oxide, by A. Geuther, shows that it is dimorphous, the yellow modification crystallizing in rhombic forms, and the red in the tetragonal system. The yellow oxide is changed by pressure and by friction into the red form, which is again transformed into the yellow, when heated to its melting point. — (*Ann. chem.*, ccxix., 56.) C. F. M. [312

Artificial reproduction of barite, celestite, and anhydrite. — A. Gorgeu finds that the sulphates of barium, strontium, and calcium dissolve freely in the melted chlorides of various metals at a red heat. On cooling, they separate in well-defined crystals which resemble closely the natural sulphates. From the results of his experiments, M. Gorgeu concludes that the minerals barite, celestite, and anhydrite must have been deposited from a solution of their amorphous sulphates in some metallic chloride. — (*Comptes rendus*, xvi. 1734.) C. F. M. [313

A modification of V. Meyer's apparatus for vapor density determinations. — In order to obtain a uniform temperature, H. Schwarz surrounds the tube containing the substance with a jacket which serves as an air-bath. The required temperature is obtained by placing the apparatus in an ordinary combustion-furnace. — (*Berichte deutsch. chem. gesellsch.*, xvi. 1051.) C. F. M. [314

METEOROLOGY.

Barometric laws. — The weather review issued by the *Deutsche seewarte* contains not only summaries of the weather conditions in each month, and of the work of the bureau in connection with them, but also occasional articles of scientific value, based upon the observations. The number for the year 1882 contains a valuable paper entitled *Typische witterungserscheinungen*, the object of which is to discuss the laws governing the velocity and direction of the movement of areas of low pressure, and their attendant phenomena, deduced from European observations between 1876 and 1880. The low areas during this period are grouped into five classes, according to the directions of the paths which they pursued. The accompanying charts exhibit, for each of three positions of the storm-centre (the entrance, middle position, and departure, as regards the territory of western Europe), six attendant phenomena, — the distribution of pressure and temperature, barometric changes in the preceding twenty-four hours, temperature departures from the normal, amount of precipitation, and cloud-phenomena. Tables are also given showing the distribution of the storm-tracks, with respect to the time of year, the average depth of the depressions, and their velocity.

The discussion to which the charts and tables have been subjected brings out various empirical laws, which are of special aid to the officers of the *seewarte* in their weather forecasts, as well as of scientific interest. Several of these may be mentioned: 1°. The depressions usually advance in the direction of the strongest winds. 2°. The line of advance of the depression forms an angle with the line of greatest increase of temperature, which generally lies between 45° and 90°, the highest temperature lying at the right of the path of the minimum. In summer the angle is greater than in winter, often reaching 90°. Both of these laws conform to the principles laid down in 1872 by Ley. They may be combined into one as follows: "The onward movement of the depressions follows approximately in the direction of the preponderating movement of the whole mass of air in the vicinity of the depression." The importance of cloud-studies, especially of the upper clouds, consists in the fact that their direction of movement foreshadows, in a general way, the direction of movement of the depression. On the other hand, their distribution in advance of the depression is so irregular that their indications cannot be relied upon alone, but must be combined with the distribution of pressure and other meteorological conditions.

The most interesting part of the discussion relates to the distribution of pressure at the height of 2,500 metres. The barometric readings are reduced to this height (in addition to the usual reduction to sea-level) by means of Köppen's formula, published in 1882; the first use of this method which has yet been published, as far as known. At this height the minima are not so closely enclosed by the isobars as is indicated by the charts; and it is shown, that "the rotary motion is limited to the lower atmospheric strata, in which the axis of the vortex is inclined towards the left and apparently somewhat forward." It seems that an advance in our knowledge of barometric movements might be made by further attention to this method of research, which enables us to investigate the extent of a depression in a vertical direction as well as in the horizontal direction, to which investigation has hitherto been limited. — (*Monatl. übersicht witterung*, 1882.) W. U. [315

GEOGRAPHY.

(Arctic.)

Polar stations. — The Austrian steamer Pola reached Jan Mayen, Aug. 3, and found the party in excellent health and spirits. We have already announced their safe return to Vienna. Some account of the wintering is given in *Nature*, from which we learn, that, in 1882, the autumn storms began with a heavy snowfall about the end of August. September was fine and warm; October again stormy. The polar night began Nov. 12, and ended Jan. 30. Aurora was constant and of great brilliancy during the winter. The greatest cold (−63° F.) was observed in January, but March had the lowest average temperature. Terrible snow-storms occurred at intervals; the ice, which first formed around the island in December, being frequently broken up, and the salt spray carried a long distance inland. The ice disappeared by the end of June. There had been no illness, and the international programme had been perfectly carried out. —— In addition to the international stations, the physical laboratory at Upsala has made simultaneous observations for the year ending Aug. 15. —— The Swedish expedition arrived at Tromsö from Spitzbergen, Aug. 28. The year's observations were completed Aug. 23. No casualties had occurred among the members of the party, and the relieving vessel encountered no ice of consequence. —— The Dutch, party which wintered in the Varna, near Waigatz Strait, arrived at Hammerfest, Sept. 3. The Varna was nipped Dec. 24, 1882, but did not founder until July 24, 1883. One of the crew died during the winter. The observations, except those relating to magnetism, were carried on with success. After the vessel sank, the party was accommodated on the Dimfna, from which it was taken by the steamer Obi, and carried to Vardö. Hovgaard, in the Dimfna, was confident of getting into open water in August, but intended, if he did not succeed in doing so by Aug. 15, to despatch half the crew under Lieut. Olsen for Yalmal on the Siberian coast, while he remained on the vessel with the other half during the winter. The Dimfna has since arrived at Vardö. —— No attempt is to be made to reach Greely's party this year, as the season is considered too late. Several Eskimo stories have reached civilization, aud have been supposed to refer to that party. It is certain that they are entitled to no credence whatever, in the shape in which they are received, even if originally based on some actual fact, which is doubtful. —— The Point Barrow party under Ray has been successfully relieved, and reached San Francisco, Oct. 7. According to a telegram from Lieut. Ray, all work was accomplished except the pendulum observations. The relieving schooner Leo reached Point Barrow, Aug. 22, but was forced away by the ice the same night; returned on the 24th, but was again forced to retire, with some damage, the next day. On the 27th, however, the party and stores were embarked, and the vessel reached Unalashka, where she was beached and repaired. Lieut. Schwatka and party, who had descended the Yukon from the Chilkat country to the sea, and reached St. Michael's safely, were brought to San Francisco by the Leo. — W. H. D. [316

The whaling-season. — Reports from Bering Strait to latest dates still continue to characterize the season as the worst and most icy for many years. No serious casualties had occurred since the loss of the John Howland. — W. H. D. [317

Arctic notes. — The death of Admiral Sir Richard Collinson, at the age of seventy-two, is announced. He commanded the Franklin search expedition, 1850–54, on the Enterprise and Investigator, surveyed Minto Inlet and Prince Albert Sound in 1852. Part of his command under M'Clure, by walking from their vessel in Mercy Bay, over the ice to the Resolute at Dealy Island, and afterwards sailing for England on the North Star, made the north-east passage from the Pacific for the first and only time. Collinson received the gold medal of the Royal geographical society, the order of the Bath, and had been deputy-master of Trinity House since 1875. —— The latest news from the polar station at the Lena mouth was to the effect that all were well April 3, though the winter had been very trying. The lowest temperature observed was −52°.3 F., Feb. 9. The deviation of the magnetic needles was very great, especially during 'magnetic storms,' reaching 25° in azimuth in the declinometer, and 90° for the suspended magnet in observations for horizontal intensity. —— The newspaper accounts of Lieut. Schwatka's voyage are so confused, and contain so many absolute errors, that it is difficult to know exactly what they are intended to convey. The facts appear to be, that he crossed the portage from the Chilkat River to the Kussooa affluents of the Lewis River, as several parties of prospectors have done before him. The descent was then made to the Yukon, at Fort Selkirk, on rafts. Some of the Indians of the party becoming mutinous, it is reported that three of them were killed by Schwatka; and the party then descended the river from the site of Fort Selkirk to Fort Adams, just below Nüklükahyet', about longitude 152° 30′ west, where one of the river-boats used in trading was chartered to take them to the seacoast. It is to be hoped that astronomical observations have been made by the party, which, so far as merely traversing the country is concerned, has done no more than has been done by different parties of prospectors and explorers before; none of whom, however, obtained any observations of precision on the river above Fort Yukon. —— Lieut. Stoney, U.S.N., after delivering the presents to the Chukchi of St. Lawrence Bay, which were sent in return for their benevolence to the officers and men of the Jeannette search expedition, on the U.S.S. Rodgers, landed near Hotham Inlet, and, according to newspaper reports, attempted to explore one of the three large rivers which fall into this estuary. The information given by the daily press is not exact; but it appears that the chief work accomplished was the collection of some native reports in regard to one of these rivers, which, in the state they have been made public, are incompatible with the known geography of the region. Doubtless, in this as in the case of Lieut. Schwatka's party, when the official reports are received, they will be found to contain welcome additions to our knowledge of these regions. [318

BOTANY.

Color-changes of lungwort flowers. — Dr. Müller finds, that while occasionally insects visit the blue (older) flowers of Pulmonaria officinalis, but without benefit to themselves or the plant, the red (younger) flowers are much more frequently visited for pollen and nectar, being at the same time fertilized. One female of Anthophora pilipes, for example, was seen to visit only red flowers, or those just beginning to change. Another visited, at first, both red and blue flowers, but later, apparently learning by experience that the blue flowers contain no nectar, confined her visits to the red flowers. A third visited in the following order: sixteen red flowers of Pulmonaria, one blue Nepeta glechoma, twenty-three red Pulmonaria, one Nepeta, twenty-one red Pulmonaria, and one Nepeta. Coming, now, to a place where the ground-ivy prevailed, she visited sixty-one Nepeta flowers, then five red Pulmonaria flowers, after which she returned to her nest. Earlier observation has also shown that this bee is not constant in its visits to a given species. The visits of the second individual and of one or two other insects, watched but a short time, to the blue flowers, is attributed to their lack of experience on this species; while the promiscuous visits of others are believed to be due to a noticeable confusion which was manifested after one or two unsuccessful visits had been made to flowers drained by earlier comers. From his observations, the writer concludes that the blue color of the older flowers, like the final color of those of Ribes aureum and Lantana, is of twofold advantage to the plant, — on the one hand increasing the conspicuousness of the flower-cluster, while, on the other hand, it indicates to the more acute of the visiting insects the flowers to which their attentions should be confined for their own good and that of the plant. — (*Kosmos*, 1883, 214.) W. T. [319

Insects versus fertilization. — In some notes on Thripidae, Mr. Osborn discusses the food-habits of these minute insects, believing, from the structure and position of their mouth-parts, and such observations as he has been able to make, that the major part of the group are vegetable feeders, the few species considered by Walsh and Riley as insectivorous differing in this respect from most of their congeners. Even these are thought to possibly seek the honey-dew of aphides, etc., rather than to destroy them.

Of young apple-blossoms frequented by them, "eighty per cent were injured by punctures upon the styles and other parts, but particularly the styles; and all the evidence pointed to the thrips as the cause of injury," though they were never seen to actually puncture the tissue. — (*Canad. entom.*, Aug.) W. T. [320

ZOÖLOGY.

Origin of individuality in the higher animals. — H. Fol has published a very interesting note, in which he studies, not the historical or phylogenetic, but the physiological, origin of the individual. The questions proposed are, At what moment in the ontogeny is the individuality created and limited? What factors determine the development of one, two, or several embryos from a single vitellus? The cases of double monsters by union of two distinct eggs, and polymerism, being phenomena of a different order, do not come into consideration here.

Fol's new researches were made principally on the sea-urchin, Strongylocentrotus lividus, which is strictly individualized at all stages of its existence. He had previously reached the conclusion that normal fecundation demands only one spermatozoon for each egg. Selenka thinks that two or three do not involve the sequel of an irregular development. Fol has verified both points, and finds that normal fecundation may be effected by either one or two spermatozoa uniting with the egg-nucleus. Three seem to produce abnormalities. The spermatozoon, then, does not act as an individuality: it represents only a certain dose of nuclear substance; and the dose may be either single or double. Immature or injured eggs admit several spermatozoa. Very ingeniously Fol has produced such a condition temporarily by immersing the mature ova for a moment in water saturated with carbonic acid, then transferring them to well-aerated water, and impregnating. The half-asphixiated eggs admit each three or four spermatozoa, which unite with the female pronucleus, after which follows an abnormally long period of repose. When segmentation begins, there appears a complex caryolytic figure, with three or four poles instead of two, a triaster or tetraster, or two parallel amphiasters, separate or united. The number of segmentation-spheres formed is at least double the normal. The larvae have irregular forms, and often two or three gastrular cavities.

If the eggs are more completely under the influence of the carbonic acid, from five to ten spermatozoa may gain entrance. The earliest comers unite with the female pronucleus: the later ones remain in the periphery. The nucleus forms a tetraster or double amphiaster; and the peripheral male pronuclei form each an amphiaster, which usually join end to end, forming a rosary of asters and spindles. Each of these amphiasters seems to be a centre of development, for the surviving larvae are polygastric.

These facts lead to the conclusion that neither the egg, nor the female pronucleus, nor the spermatozoon, suffices, taken separately, to determine the individuality. The dose of nuclear substance resulting in the formation of an embryo may vary within considerable limits; and the number of amphiasters at the first cleavage is the first criterion which decides the number of individuals. Fol then considers the first amphiaster of segmentation as the first fact of individuality. [Fol does not appear to have demonstrated a strict correspondence between the number of amphiasters and of individuals. His view raises the question whether there is a fundamental difference between the bipolar (amphiasters) and multipolar asters in cell-division.] — (*Comptes rendus acad. Paris*, Aug. 13, 1883.) C. S. M. [321

VERTEBRATES.

Birds.

The white of birds' eggs. — Tarchanoff has discovered that the white of the eggs of those birds whose young are born unfeathered differs from ordinary albumen, its most striking peculiarity being that it remains transparent after coagulation by heat. He designates it as 'tata-eiweiss.' It differs from ordinary white of egg in many respects. When coagulated it is fluorescent. It has less polarizing power, and contains more water, than the white of hens' eggs. It gives no precipitate when abundantly diluted with water. It is at first strongly alkaline, but loses that reaction as the yolk develops. It is rapidly digested. It can be redissolved in water after drying at 40° C. It can be changed into what appears to be identical with ordinary albumen, *a*, by the addition of a few drops of concentrated solutions of neutral salts of alkaline bases, or, *b*, of concentrated acetic or lactic acid; c, under the influence of carbonic acid at a temperature near boiling; d, by incubation (owing to the action of the CO_2 excreted by the yolk? — *Rep.*). Experiments left it uncertain whether the ordinary albumen first passes through the 'tata' form. It seems probable that the 'tata-eiweiss' is a sodic or potassic albuminate. — (*Pflüger's arch. physiol.*, xxxi. 368.) C. S. M. [322

Yolkless artificial eggs. — Tarchanoff, in the course of his experiments, noticed in the preceding abstract, made fistulae of the oviduct in hens. They bear the operation well, but it causes atrophy of the glands of the oviduct, and apparently of the ovary also. The mature ova are discharged into the body-cavity. Under favorable circumstances, if a ball of amber is introduced into the upper end of the duct, the white with fully developed chalazae, and the membranous shell, are deposited, producing a normally formed egg, in which the yolk is replaced by the amber ball. A ligature prevented the descent of the egg, during the experiment, into that region of the oviduct which secretes the calcareous shell. — (*Pflüger's arch. physiol.*, xxi. 375.) C. S. M. [323

ANTHROPOLOGY.

Notes on New Guinea. — By degrees this unknown land is being brought before the scientific world. Mr. W. G. Lawes, writing from Port Moresby, describes a visit to the Rouna Falls, accompanied by his wife, the first lady to tread the unbeaten tracks of New Guinea. In the district of Sogere the travellers stopped at several native villages. The one where they camped consisted of seven houses and three tree-houses, which are really forts or castles. One was a hundred and twenty feet high. A native went up with an armful of spears, and threw them down at an imaginary enemy. When they have reason to expect an enemy, they take up a supply of big stones. These houses command the whole village, and could not easily be taken. The travellers saw much of the natives, who are good specimens of the average Koiarian. They are somewhat darker, shorter, and more hairy, than the coast people. When a man dies, it is always known whose spirit has bewitched him; and his tribe must pay in order to give the dead man rest. Whenever a man of the least consequence dies, there is fighting. Their mode of getting fire is peculiar. They take a dry stick of pithy wood, and split it a little way. In the cleft they put a piece of wood or a stone to keep it open; then, putting a little rubbish as tinder under the split part of the stick, they stand on the other end, and pass a strip of rattan, cane, or bamboo, under the cleft, drawing it rapidly up and down, when it soon begins to smoke, and sparks appear between the forks of the stick, which, with a little care, sets fire to the tinder, and a flame is soon obtained. — J. W. P. [324

The Toltecs. — Notwithstanding Dr. Brinton's consignment of the Toltecs to the Morgenland, M. E. T. Hamy has the courage to say, "The Toltecs play the most important part in the past history of North America. Their history commences with the fifth century of our era, and their migration to the south-east coincides in a striking manner with the great movement of peoples in the old world. When the Goths and Huns were annihilating the civilization of Europe, at the other end of the world other barbarians, travelling in the same direction, were destroying older nations." M. Hamy gives a brief review of the Toltec art, especially in clay, and then proceeds to enlarge upon the discoveries of M. Charnay, illustrating his remarks by means of specimens in the Lorillard collection. The first period of Toltec ceramic art is termed *pastillage*; the second, more advanced, may be called *poussage*. Tula, Teotihuacan, and Cholula contain the most imposing vestiges of Toltec grandeur. The remains of what was the first capital of the Toltecs are situated nineteen leagues north of Mexico, at the confluence of the Rio Grande de Tula and a small river from the mountains of Texas. M. Charnay visited the ruins of this place, and photographed the most important. The descriptions of the other two capitals are passed over briefly by M. Hamy; but of Cholula, fortunately, we have the very minute observations of Bandelier, to be published by the Archeological institute. — (*Assoc. sc. France*, Conférence 25 Mars, 1882.) J. W. P. [325

The perforated humerus. — Professor Henry W. Haynes, in exhibiting a perforated Indian humerus found at Concord, Mass., brings together some important references to the same phenomenon observed elsewhere. Mr. Henry Gilman found 50 % in the Michigan mounds; at Grenelle, Paris, M. Martin found 28 %; in the Furfooz race of the caves of Belgium, M. Dupont found 30 %; in the Dolmen of Argenteuil, near Paris, M. Leguay found 25 %; while Dr. Pruner Bey ascertained the average at Vaureal, near by, to be 26 %. He also reported that it is common in skeletons of the Guanches. In the cave of Orrouy, belonging to the bronze age, the average was ascertained by Dr. Broca to be 25 %. Among two thousand skeletons of the polished stone age, discovered by the Baron de Baye in Champagne, he reports it as very frequent. Prof. Ward also speaks of the broken state in which long bones are found, attributing it to design. With regard to percentages on small numbers, a very singular experience was that of the writer of this note last year. Wishing to know what races and nationalities supplied the criminals of his city, he consulted the census and the police records. The former reported one Persian in the community; the latter, five Persians, arrested and convicted. Startled by the fact that five hundred per cent of the Persians were criminals, he was about to warn the government against allowing any more to land. A few moments' study, however, set the matter right. The poor Persian on the census-roll had been 'sent down' five times during one year, for sixty days each time, on account of vagrancy. — (*Proc. Amer. antiq. soc.*, ii. 80.) O. T. M. [326

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

National museum.

Publications. — The publications of the museum are issued under two titles, — 'Bulletins' and 'Proceedings.' The bulletins consist of monographs of groups of animals, plants, or minerals; papers upon the fauna, flora, and minerals of different regions of the globe; and similar works. The proceedings contain shorter communications descriptive of new species, etc., or relating to novel phenomena. All papers are based on material in the museum. Five volumes of the proceedings, and twenty-two bulletins, have already been published, aggregating 7,396 octavo pages. The sixth volume of the proceedings, and several bulletins, are now in course of publication. The bulletins which will appear within a short period are the following: —

A bibliography of the writings of Professor Spencer Fullerton Baird, by G. Brown Goode, A.M.; Avifauna columbiana, by Elliott Coues and D. Webster Prentiss, M.D.; A contribution to the natural history of Bermuda, edited by G. Brown Goode, A.M.; A manual of herpetology, by Henry C. Yarrow, M.D.; Official catalogue of the collections exhibited by the U. S. national museum at the London fisheries exhibition, 1883.

The exhibition-halls. — Two very important objects are about to be placed on exhibition in the museum. The first of these is a group of orangs, mounted by Mr. William T. Hornaday. The group represents a fight in the treetop, in which are concerned two adult male orangs, and as spectators a female and baby, and a young male. The setting has been worked out with great care, especially as regards the nests of the orangs, the foliage, vines, orchids, etc. All the specimens were shot by Mr. Hornaday in Borneo, and are mounted from his notes upon the living and fresh specimens.

The second object of interest is an antique Roman mosaic derived from Carthage. It was exhibited at the Centennial exhibition in the Tunisian section, and was afterward presented to the museum by Sir Richard Wood, British consul-general at Tunis. The mosaic represents a lion of life-size, seizing an animal resembling a horse or ass. It is believed to date from the first century B.C.

Additions to the collections. — The museum has recently secured a very valuable collection of archeological objects from Missouri, comprising twenty-five specimens. Included among them are a digging-implement of peculiar shape, and about a foot long, and two hourglass-shaped ceremonial objects of pink quartz about four inches long. Among the recent accessions to the department of birds is a nest of Opornis agilis, with eggs, — the first specimen of which there is authentic record. The department of reptiles is at present negotiating for a specimen of the very rare North-American serpent, Ophthalmidium longissimum. The department of mammals has received a valuable accession in the form of partially complete skeletons of eleven sperm whales. They represent the remains of a small school of these cetaceans, which stranded near Cape Canaveral, Florida, in the winter of 1882-83.

Bureau of ethnology.

Pueblo of Tallyhogan. — Mr. James Stevenson reports that careful investigations in the vicinity of the abandoned pueblo of Tallyhogan, in the ancient province of Tusayan, Arizona territory, disclose the fact that the sand-dunes on the north and east of the village were used by the former inhabitants as burial-places. A very little digging exposed the remains of the interred, which were usually placed in a hole in a doubled-up, mummy-like attitude.

In many cases vases and bowls, which probably contained food, were inhumed with the dead, and in some instances trinkets were found.

A number of old specimens were secured, among them being small images of human beings (previously unknown to collectors in this region), curious in workmanship, and ancient in ornamentation.

NOTES AND NEWS.

Mr. G. K. Gilbert has recently given some rather disturbing suggestions to the people of Salt Lake City (*Salt Lake weekly tribune*, Sept. 20) concerning the probability of destructive earthquakes there. He describes the slow and still continuing growth of the ranges in the Great Basin by repeated dislocation along great fractures, the earth's crust on one side being elevated and tilted into mountain attitude by an upthrust that produces compression and distortion in the rocky mass, until the strain can no longer be borne, and something must give way. Suddenly and violently there is a slipping of one wall of the fissure on the other, far enough to relieve the strain, and this is felt as an earthquake; then follows a long period of quiet, during which the strain is gradually reimposed. Such a shock occurred in Owen's valley, along the eastern base of the Sierra Nevada, in 1872, when a fault-scarp five to twenty feet high and forty miles long was produced. A scarp thirty or forty feet high is known along the western foot of the Wahsatch range, south of Salt Lake, and other scarps of similar origin have been found at the bases of many of the Basin ranges. The date of their formation is not known; but it must be comparatively recent, because they are still so little worn away. Wherever they are fresh, and consequently of modern uplift, there is probable safety from earthquakes for ages to come, because a long time is needed for the accumulation of another strain sufficient to cause a slipping of one wall of the fissure on the other. Conversely, when they are old and worn down, the breaking strain may even now be almost reached, and an earthquake may be expected at any time. This is the case at Salt Lake; for, continuous as are the fault-scarps along the base of the Wahsatch, they are absent near this city. From the Warm Springs to

Emigration Cañon they have not been found, and the rational explanation of their absence is that a very long time has elapsed since their last renewal. In this period the earth-strain has been slowly increasing. Some day it will overcome the friction, lift the mountains a few feet, and re-enact on a fearful scale the catastrophe of Owen's valley.

— The president of the International committee Dr. H. Wild, by request of the governments concerned, has announced that the observations of the parties at the circumpolar observing stations were to cease, as was originally planned, in September, 1883, and the different expeditions will return as shortly thereafter as practicable.

— Violent solfataric disturbances were experienced in Iceland between the 12th and 21st of last March.

— The English government has decided to establish an astronomical and meteorological observatory at Hong Kong, and has appointed Dr. William Doberck director of the institution. Dr. Doberck has accepted the position, and removed to Hong Kong. He may be addressed through the Crown agents for the Colonies, Downing street, London.

— In the *Journal of chemical industry* of June 29, Mr. G. W. Wigner, F.C.S., F.T.C., gives an account of the damage done to delicate substances by the material in which they are packed, suitability being too often sacrificed to strength, lightness, or mere ornament. As president of the society of public analysts, Mr. Wigner has had many opportunities of studying the subject.

Oysters, he writes, have been imported into England in barrels made of wood containing a very large proportion of tannin, with results which can be better understood than appreciated. The iron contained in the liquor has produced a very noticeable proportion of ink, and the oysters themselves have become converted into a poor but certainly novel kind of leather. Tinned fish and tinned acid fruits have been packed in vessels in which lead predominated over tin to a very marked extent. He alluded to the loss in cargoes of essences and scents by the impossibility of making the stoppers of glass bottles absolutely air-tight, and the damage done to other parts of the cargo by those essences. Mr. Wigner then proceeds to describe the effects of evaporation in the hold of a ship: bilge-water can never be quite excluded, and change of temperature must produce evaporation; the dew thus produced settles on the top of the packing-cases, and in time corrodes the metal, or is absorbed, as the case may be, and, if the voyage be long enough, damages the goods. Canned goods, he writes, seldom remain good for a second season, even if apparently well packed: the tin, some of the iron, and the lead contained in the tin, are dissolved, and the contents of the can become contaminated with these metallic substances.

The greater part of Mr. Wigner's article is devoted to the effects produced on tea by the wood in which it is packed. The Chinese formerly used 'toon' wood only; but the forests have been so much cut down that the supply is running short, and in Assam, wood for packing-cases is cut at random. In one instance, a consignment of Assam tea had a distinctive odor of its own, resembling a new and excessively rank kid glove; some hundreds of chests being thus damaged. The inner lead coating of tea-chests used by the Chinese is much purer, and less liable to damage by acid, than the lighter lining used by the dealers in upper India.

— Professor Angelo Heilprin was elected one of the curators of the Academy of natural sciences of Philadelphia on Oct. 2, to supply the vacancy caused by the death of Mr. Charles F. Parker. At a meeting of the council, held Oct. 5, Professor Heilprin was appointed actuary to the curators or curator in charge. He has commenced the arrangement of a department of the museum to be devoted exclusively to the natural history of Pennsylvania and New Jersey. The geology and mineralogy, together with the fauna and flora, of the two states, will be represented as completely as possible, and will form a collection which cannot fail to be of special interest to local students.

— The papers read at the meeting of the Biological society of Washington, Oct. 19, were by Dr. Theodore Gill, The ichthyological results of the explorations of the U. S. fish-commission steamer Albatross in 1883; Dr. C. A. White, Character and function of the epiglottis of the bull-snake (Pityophis); Professor Lester F. Ward, Note on an interesting botanical relic of the District of Columbia; Dr. C. V. Riley, Manna in the United States.

— The Philosophical society of Washington, on Oct. 13, held its first session after the summer vacation. Since June it has lost three members by death. — Surgeon-Gen. C. H. Crane, who was one of its vice-presidents; Admiral B. F. Sands, one of the original founders of the society; and Dr. Josiah Curtis. The papers of the evening were by Mr. William B. Taylor, on the Rings of Saturn; by Dr. Swan M. Burnett, on the Character of the focal lines in astigmatism; and by Mr. H. A. Hazen, on Thermometer-exposure.

— A scientific session of the National academy of sciences will be held in New Haven, at Yale college, commencing on Tuesday, Nov. 13.

— Mr. F. W. Putnam, of the Peabody museum, Cambridge, announces his readiness to give lectures on American archeology, based upon the course delivered last year before the Lowell institute. His subjects cover such matters as the shell-heaps, caves, mounds and earthworks, stone graves, pueblos, and ancient arts and religious rites of our country, as well as general sketches of the archeology of North America, Mexico and Central America, South America, and Peru.

— At the meeting of the Engineers' club of Philadelphia, Oct. 6, Mr. Edward Thiange presented an illustrated description of a method of earthwork computation, by means of diagrams constructed from the proposition, 'The areas of similar figures are to each other as the squares of their homologous sides.' An idea may be had of their nature and uses by the following directions: to get the average volume in cubic yards of a station (in embankment), to the centre-fill at each end add the constant height of the 'grade triangle' (which is formed by the road-bed and the side-slopes produced); at the resultant heights on the diagram, measure, with the scale of cubic yards, the lengths of the ordinates terminated by the slope-lines at each station respectively; their sum, diminished by the 'grade prism,' is the average quantity for the station of one hundred feet.

—A paper upon Economy in highway bridges, by Prof. J. A. L. Waddell, was read. Its objects are to determine the most economical depth and number of panels for spans from forty to two hundred feet; the lengths at which it is better to change from pony truss to thorough bridge, and from single to double intersection; the exact dead loads, and the amounts of lumber and iron for each case.

— Mr. Lester F. Ward has published in the U. S. fish-commission bulletin a list of the marsh and aquatic plants of the northern United States, which will be useful to those interested in aquaria and fish-ponds. The list numbers a hundred and eighty-one species, sixty-one of which are strictly aquatic, the balance being found in marshy places. Three species are said by Dr. Hessel to be injurious to carp-ponds; viz., Nuphar advena, Nuphar sagittaefolium, and Bidens Beckii. The species recommended especially for carp-ponds are of the strictly aquatic genera, Utricularia and Potamogeton. Of the Compositae, only three species, all Bidens, are given as being marsh-loving, or aquatic.

—The director of the Imperial Japanese government laboratory at Yokohama, Dr. A. J. C. Geerts, died there Aug. 30, aged forty.

—We have just received intelligence of the death of the distinguished French paleontologist, Dr. Joachim Barrande.

RECENT BOOKS AND PAMPHLETS.

Bacharach, M. Abriss der geschichte der potentialtheorie. Göttingen, *Vandenhoeck & Ruprecht*, 1883. 3+78 p. 8°.

Bericht, offizieller, über die im königlichen glaspalaste zu München 1882 stattgehabte internationale elektricitäts-ausstellung, verbunden mit elektrotechnischen versuchen. Red. W. v. Beetz, O. v. Miller, E. Pfeiffer. Leipzig, 1883. 244+154 p., illustr. 4°.

Bernstein, H. A. Dagboek van de laatste reis van Ternate naar Nieuw-Guinea, Salawati en Batanta 1864–65, uitgavet door S. C. van Musschenbroek. Met aanteekeningen, bijlagen en kaart. 's Gravenhage, 1883. 258 p., map. 8°.

Biehringer. Schematische darstellung elektrodynamischer maschinen. 2 chromolithogrische wandtafeln. Nürnberg, 1883. f°.

Blakesley, T. H. Electricity at the board of trade. London, *Low*, 1883. 24 p. 8°.

Block, J. Origines de l'electricité, de la lumière, de la chaleur, et de la matière. Nancy, 1883. illustr. 8°.

Brown, J. C. Finland: its forests and forest management. London, *Simpkin*, 1883. 306 p. 8°.

Chastaingt, G. Catalogue des plantes vasculaires des environs de La Chatre (Indre). Châteauroux, 1883. 199 p. 8°.

Cracau, J. R. B. Ob und wann? Ein versuch zur beantwortung der frage nach der möglichkeit und dem zeitpunkte des weltunterganges. Braunschweig, *Graff*, 1883. 33 p. 8°.

Dahl, F. Analytische bearbeitung der spinnen Norddeutschlands. Kiel, 1883. 100 p., illustr. 8°.

D'Arzano, A. Les habitants de la mer et la flore marine. Limoges, 1883. 120 p. 12°.

Dietrich, R. Die darstellung der wurzeln der algebraischen gleichungen durch unendliche reihen. Inaug. diss. Jena, *Deistung*, 1883. 44 p. 8°.

Dubois, A. Croquis alpins, avec une notice sur la flore alpestre, par F. Crepin. Bruxelles, 1883. 519 p., illustr. 8°.

Elektrotechnische rundschau. Illustrirte zeitschrift zur verbreitung nützlicher kenntnisse aus dem gebiete der angewandten elektricitätslehre. Red. Stein. heft 1. Halle, 1883. illustr.

Fabri, R. Impressioni della esposizione di elettricità a Parigi; con aggiunte che si riferiscono al primo Congresso internazionale degli elettricisti. Santagata, *Feltria*, 1882. 140 p. 16°.

Fleck, H. Ueber die chemie in ihrer bedeutung für die gesundheitspflege. Berlin, 1883. 8°.

Gaffron, E. Beiträge zur anatomie und histologie von Peripatus. Inaug. diss. Breslau, *Köhler*, 1883. 32 p. 8°.

Galle, A. Berechnung der proximitäten von asteroidenbahnen. Inaug. diss. Breslau, *Köhler*, 1883. 60 p. 8°.

Glaischer, J. Factor table for the sixth million: containing the least factor of every number not divisible by 2, 3, or 5, between 5,000,000 and 6,000,000. London, *Taylor*, 1883. 4°.

Gustave, F., et **Héribaud-Joseph**, F. Flore d'Auvergne, contenant la description de toutes les plantes vasculaires qui croissent spontanément dans les département du Puy de Dôme et du Cantal, des clefs analytiques et un vocabulaire des termes employés. Clermond-Ferrand, 1883. 624 p. 16°.

Hauck, W. Ph. Die grundlehren der elektricität mit besonderer rücksicht auf ihre anwendungen in der praxis. Wien, 1883. 293 p., illustr. 8°.

Hauftmann, C. Bedeutung der keimblättertheorie für die individualitätslehre und den generations-wechsel. Inaug. diss. Jena, *Deistung*, 1883. 41 p. 8°.

Henneguy, Ch. Les lichens utiles. Paris, 1883. 120 p., illustr. 8°.

Hess, E. Einleitung in die lehre von der kugelteilung mit besonderer berucksicht ihrer anwendung auf die theorie der gleichflächigen und der gleicheckigen polyeder. Leipzig, *Teubner*, 1883. 10+475 p., 16 pl. 8°.

Hjelt, E. Grunddragen af allmänna organiska kemin. Helsingfors, 1883. 160 p. 8°.

Kallenbach, E. Polynoë cirrata O. Fr. Mllr. Ein beitrag zur kenntniss der fauna der Kieler Bucht. Inaug. diss. Jena, *Deistung*, 1883. 38 p., 1 pl. 8°.

Kauffmann, G. Ueber den β-naphtolaldehyl und seine derivate die β-naphtolcarbonsäure und das β-naphtolcumarin. Inaug. diss. Breslau, *Köhler*, 1882. 37 p. 8°.

Krämer, J. Die elektrische eisenbahn bezüglich ihres baues und betriebes. Wien, 1883. (Elektro-techn. bibl. xvii.) illustr. 8°.

Kremser, V. Die bahn der 2 cometen von 1879. Inaug. diss. Breslau, *Köhler*, 1883. 43 p. 8°.

Kuntze, O. Phytogeogenesis. Die vorweltliche entwickelung der erdkruste und der pflanzen in grundzügen dargestellt. Leipzig, 1883. 240 p. 8°.

Lankester, E. The cholera: What is it? and How to prevent it. London, *Routledge*, 1883. 8°.

Lista, R. Mis esploraciones y descubrimientos en la Patagonia 1877–80. Buenos Aires, 1883. 213 p., illustr. 8°.

Love, G. H. Étude sur la constitution moléculaire des corps, sur les lois des volumes moléculaires, des chaleurs spécifiques et des dilatations. Précédée d'une introduction sur la définition de la loi et celle de la force. Paris, 1883. 2 pl. 8°.

M., M. K. The birds we see, and the story of their lives. N.Y., *Nelson & sons*, 1883. 3+93 p., illustr. 16°.

Macé, E. Les Lycopodiacées utiles. Paris, 1883. 80 p. 4°.

Macgregor, J. L. L. The organization and valuation of the forests on the continental system in theory and practice. London, 1883. 318 p. 8°.

Manson, P. The Filaria sanguinis hominis, and certain new forms of parasitic disease in India, China, and warm countries. London, *Lewis*, 1883. illustr. 8°.

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SCIENCE.

FRIDAY, NOVEMBER 2, 1883.

OSWALD HEER.

Oswald Heer, whose death in his seventy-fifth year we announced a fortnight since, was born in Glarus, Switzerland, Aug. 31, 1809. In 1828 he went to Halle to study theology and natural history. He began his career as a pastor at Glarus; and certain habits and manners of a clergyman clung to him throughout life, and traces of them may even be seen in his special paleontological writings. He soon gave up the ministry, and devoted himself exclusively to natural history; and we next find him settled in Zurich, where, in 1835, he founded the botanic garden, and became its director. In the following year he was attached to the university as professor of botany and entomology, — the two studies which divided his time throughout his life. Later, about 1855, he transferred his allegiance to the Polytechnicum, an institution of world-wide fame, where he remained the rest of his life. In 1845 he founded and became president of the Zurich society of agriculture and horticulture. And for twenty years he was a Rathsherr, or member of the Grand council of Zurich.

It was not until 1840 that he turned his attention to paleontology, studying first of all the fossil insects of Oeningen. This task he undertook at the instance of his friend Escher von der Linth. Knowing him from his childhood, Escher quickly perceived that a mind so delicately adjusted to observation, which no detail escaped, was well prepared for the difficult work of determining and classifying the numerous plants and insects of Oeningen. It was a virgin field. Yielding to the solicitations of his friend, Heer bravely undertook the suggested work; and with scarcely an interruption, notwithstanding a constitution always delicate, he brought out the remarkable and numerous memoirs which have given him a place among the first paleontologists of our time.

Soon after his return to Switzerland, Heer associated himself with Froebel (since renowned for his reforms in pedagogy) in the publication of a magazine under the title of '*Mittheilungen aus dem gebiete der theoretischen erdkunde*,' of which only four numbers were ever issued. In the first of these, in 1834, Heer printed two memoirs on the geographical distribution of insects and plants in the Swiss Alps, drawing his material mainly from his native canton, — memoirs which show, especially the longer one on insects, that he must have gathered his facts through patient, diligent observations of many years. These two memoirs appear to have been his earliest essays. He afterwards expanded the first into a long and better known memoir on the Swiss Coleoptera. These studies on geographical distribution formed an excellent basis for the paleontological work to which he was shortly to devote himself, one great value of which lies in his careful studies of the relations which the extinct insects and plants investigated bear to living forms in the same or other parts of the world. From this time on, not a year has passed without some sign of activity from this indefatigable student; and his last volume was only last month reviewed in our columns. At first the memoirs concerned mainly the transformations or distribution of Swiss Coleoptera, and the distribution of alpine plants; but from 1847, when his first memoir on the tertiary beetles of Europe appeared, his attention was directed almost exclusively to fossil insects and plants, especially those of the tertiary epoch; and it is here he has won his renown. The volume upon tertiary insects, issued between 1847 and 1853, opened a new world to science, and will forever remain the classic work on fossil insects. He brought to it a painstaking and faithful investigation, which in many cases will bear the closest scrutiny at the present time, notwithstanding the advance of entomology in the generation since elapsed. Finding that the determination of fossil insects must depend largely upon a study of their wings, he made a special investigation of the neuration in living types, and proposed for the first time a uniform nomenclature for all orders of insects. From its burial in a memoir on fossil beetles, this scheme received little attention; but it remains to-day the most philosophical presentation of the subject.

Although his earlier paleontological papers were mainly devoted to insects, his attention was from the first attracted to the plants associated with them. And, the mass of insects from Oeningen disposed of, his memoirs now became more and more largely paleobotanical. To these he gave a living interest, from his discussions of the probable physical condition and climate of tertiary time, drawn from the data furnished by the plants. He was a strong believer in a miocene Atlantis. His first essay, dealing with ancient climates, was published in Giebel's *Zeitschrift* in 1859, and was afterwards expanded into a volume, which passed immediately through a much enlarged second edition (in French) by the assistance of his friend Gaudin.[1] Then followed that remarkable series of illustrated quarto memoirs, published in various countries and languages in London, Stockholm, St. Petersburg, Zurich, etc., in which the collections of various government expeditions are described and figured, and which he afterwards collected into the volumes which compose his 'Flora fossilis arctica' (7 vols.), companion volumes to his 'Flora tertiaria Helvetiae' (3 vols.) and 'Flora fossilis Helvetiae.' His studies upon past climates were also carried into wider geologic fields, and resulted in his 'Urwelt der Schweiz,' a living picture of the past of his native country, clothed in popular language. His imagination was here brought into play, and occasionally expressed itself in verse. This volume, issued in 1865, was translated into French by Gaudin (1875), and into English by Heywood (2 vols. 1876). To each of these editions he added supplementary matter,

[1] This last was also enriched by contributions from several naturalists, notably Matheron and Saporta.

and himself published a considerably enlarged German edition in 1878.

Heer, who, as we have said, was instigated to his paleontological studies by Escher, was glad to acknowledge his debt to his friend, whose most illustrious pupil he was. Rarely have such cordial relations existed between two men. He always spoke of Escher in terms of warm friendship and admiration, and always seemed to be asking, Did you ever know his equal? And, indeed, Escher merited his praise.

Without personal fortune, and very often obliged by illness not only to suspend his courses, but even to make expensive journeys to Madeira, Italy, etc., to regain his strength, Heer would have been greatly embarrassed but for his friend. Escher possessed a fair fortune, especially in the latter part of his life; and, being childless, he constantly sought opportunity to assist Heer, and, so far as possible, without his knowledge. Escher urged his gratuities with such delicacy and kindness that he seemed to be the one under obligation when his dear friend would accept his offerings. Escher recognized the worth of his *protégé*, appreciated the value of the services he was rendering to science, and welcomed with a beaming face every fresh memoir from Heer's pen.

Heer was a man of very retiring habits, being rarely seen in public, even on the street. His delicate health forbidding his travelling or making personal explorations, he lived in his study, where he received fossils from all parts of the world. Here he accumulated specimens from the arctic regions, from every country of Europe, from Asia, and from America. Here in the midst of cabinets, and with books piled up on every side, he passed all his time, yet always receiving his geological friends with manifest pleasure. Many a scientific man came here to visit the illustrious paleontologist, — Leopold von Buch, Sir Charles Lyell, von Hauer, Geinitz, Fraas, Oppel, Sismonda, Ramsay, Falconer, Pictet, Studer, Merian, Agassiz, de Zigno, Mojsisovics, Gumbel, Schimper, Zittel, Schmidt, Abich, etc. While he was associated with Heer in the Polytechnicum, Jules Marcou was a visitor almost daily, and relates how, with a pleased and contented smile, Heer always greeted him after his fashion, grasping his hand in both of his. Reclining on a sofa (for Heer could only work a brief time without seeking rest), he would gladly converse for an hour or two upon geological topics and the numerous problems still requiring solution.

We have said he undertook no explorations; yet, in the winter of 1854–55, he visited Madeira for his health, in company with Ziegler and Hartwig. Several memoirs resulted from that visit; and in 1861, with his friends Escher and Merian, he visited Paris, London, the Isle of Wight, and Holland. An unusual exception was his accompanying his friend Marcou on short journeys to Oeningen, Schambelen, Dürnsten and Utznach, and Hohe Rhonen, — favorable localities for fossil plants and insects.

Heer worked quite alone, unaided by others; and he never worked in collaboration with other men, unless we may except the late C. T. Gaudin of Lausanne, who translated several of his important works, and in one at least, that on the climate of the tertiary epoch, may be said to have been a collaborator. Heer so called him. Indeed, it is possible, that had Gaudin not died in the flower of his age, eighteen years ago, he would have worked still further in concert with Heer, and given his works a wider circulation. Heer also found an assistant, as excellent as devoted, in his daughter, especially during the last twelve years of his life, many of which, after the disease which attacked him in 1872, he passed upon his bed. She was ever ready to place before him specimens, books, plates, descriptions, manuscripts. Always by his side, all his wishes were cared for by her in the most assiduous and intelligent manner.

A man more lovable, more sympathetic, a life more laborious and pure, one could scarcely imagine. As a man, he possessed the same irresistible attraction to all who came under his influence as that which characterized the late Lady Lyell.

The portrait given here has been photo-engraved from a photograph taken in 1864 by Heer's brother, kindly lent for the purpose by Professor Jules Marcou. The signature is taken from a letter addressed to the writer, under date of Aug. 13, 1883.

A HEARING OF BIRDS' EARS.[1]—III.

SECTION of bone is required for further examination of the ear parts. There being no mastoid affair to be considered as such, we may proceed directly to the 'petrous part of the temporal' (the periotic or petrosal bone); the otocrane, or otic capsule, enclosing the essential organ of audition just as the eyeball does that of vision, or the ethmoid bone that of olfaction. None of this bone is ordinarily recognizable on the outside of the skull; though in the embryo that part which is in especial relation with the posterior semicircular canal appears to a slight extent upon the occiput. The foundation of the bone is laid very early in cartilage; traces of the cochlea and canals being visible in the chick at the fifth day of incubation, if not sooner, in the primitive cartilaginous *basis cranii*, — the parachordal plate of cartilage on each side of the notochord. On longitudinally bisecting the adult skull, or otherwise gaining access to the brain-cavity, the whole cerebral surface of the petrosal bone is brought into view, as in fig. 4, *po*, *op*, *ep*. In a skull of any size, as that of an eagle (from which my description will be mainly derived), there is no difficulty in making out the parts, although the periphery of the petrosal is completely consolidated with surrounding bones. The petrosal or periotic bone consists of three distinct bones, which in some animals may remain long or permanently separate, or be consolidated with surrounding bones and not with one another. To see them it is usually necessary to examine a young skull, like that figured. These are the *pro-otic*, *po*; the *opisthotic*, *op*; the *epiotic*, *ep*. In the present case of the adult eagle, they are absolutely fused with one another, as well as with contiguous bones. The consolidated petrosal appears as an irregular protuberance upon the inner wall of the brain-cavity, much as the human petrous bone protrudes between posterior and middle cerebral fossae. It appears to be much more extensive than it really is, because the superior semicircular canal, too large to be accommodated in the petrosal, invades the occipital bone, — the track of the canal being sculptured in bas-relief, — as at *asc*, fig. 4. Behind this semicircular trace, the deep groove of a venous sinus (*sc*) is engraved upon the bone, throwing the track of the canal into still stronger relief. The top of the petrosal and contiguous occipital surface floors a fossa which lodges the enormous optic lobes (*corpora bigemina*) of the brain; in the eagle partly divided from the general cavity for the cerebral hemisphere by a bony tentorium, like that which in some mammals separates the cerebellar from the cerebral fossae. On the vertical face of the petrosal, or on the corresponding occipital surface, is a large smooth-lipped orifice leading to a tongue-like excavation which lodges the flocculus of the cerebellum, and would therefore seem to correspond to that slight chink of the human petrous bone, near the *meatus internus*, which lodges a process of the *dura mater*. In front, between the petrosal and the alisphenoid (or in the apposed border of one or the other of these bones), is a considerable foramen, — the exit of the second and third divisions of the trifacial (figs. 1 and 4, the hole marked *5*). Below the petrosal, between opisthotic and exoccipital, near the *foramen magnum*, is a foramen (which may be subdivided into foramina) representing the human *foramen lacerum posterius*, for transmission of the pneumogastric, etc. (fig. 4, the hole marked *8*). Thus, as always, the bony auditory capsule lies between the exits of the third division of the trifacial and the pneumogastric. The general space under description is continued to the margin of the *foramen magnum* by the exoccipital bone (fig. 4, *eo*). Now, on the vertical face of the petrosal itself, and in the pro-otic part, far behind the foramen marked *5* in fig. 4, considerably above that marked *8*, will be seen the large smooth-lipped orifice of the *meatus auditorius internus*, marked *7* in the figure. Here enter, as usual, both *portio dura* and *portio mollis* of the old seventh pair of cranial nerves. At the bottom of the meatus are at least two openings, small, but separate from each other. A bristle passed through the upper (anterior) one of these traces the course of *portio dura* (the facial nerve) through the fallopian aqueduct ('nerviduct,' it would be better called), and emerges in the tympanic cavity near the eustachian orifice. This orifice of exit of the facial is virtually a 'stylomastoid' foramen, though within the tympanic; for the nerve burrows through no more bone in reaching the surface of the skull. A bristle passed through the other one of the two foramina at the bottom of the meatus practically traces the course of the *portio mollis*, or auditory nerve,

[1] Concluded from No. 38.

and can also be made to come out into the tympanum, either through the vestibular or cochlear opening (*fenestra ovalis* or *fenestra rotunda*). In the dry skull, either passage is easily made without breaking down, and apparently without meeting any bony obstacle.

If, now, the whole periotic mass be cut away from the rest of the skull with a fine saw, and then divided in any direction, the bony labyrinth and essential organ of hearing can be studied. It is best to make the section in some definite plane with regard to the axes of the skull, — the vertical longitudinal, or vertical transverse, or horizontal, — as the disposition and relations of the contained structures are then more readily made out. Four or five parallel cuts will make as many thin flat slices of bone, affording eight or ten surfaces for examination. The whole course of the labyrinthine structures can be seen in sections, which, put together in the mind's eye, or held in hand a little apart, and visibly threaded with bristles, afford the required picture very nicely. At first sight, the unpractised eye will recognize nothing but confusion, — a bewildering maze of bone. All this cancellated structure or net-work, however, is pneumatic; the open-work tissue of bone containing air derived from the tympanum, and having nothing to do with the auditory cavities proper. Parts of the bony labyrinth will soon be recognized by their smooth, firm walls and definite courses, as distinguished from the irregular interstices of bone-tissue. They are, as usual, a central vestibular cavity, with its utricular recess; three semicircular canals; and the cochlear cavity, projecting downward like a beak (see figs. 5 and 6, the membranous labyrinth, to which the incasing bony cavities closely conform). According as the sections have been made, numerous cross-cuts of the canals will be seen here and there as circular orifices; the canals themselves lying curled like worms in the petrosal and occipital substance, their ends converging to the central vestibular cavity. As compared with those of man, the parts are of great size in a bird: in the eagle, for example, the whole affair is as large as the end of one's thumb, the whole length of the superior canal is an inch or more, and its calibre, I should judge, is absolutely about as great as in man. The cochlea, though not comparatively diminutive, is in an undeveloped state, as far as complexity of structure is concerned, — ligulate or strap-shaped, a little curved on itself, but making no whorl. This is substantially as in all Sauropsida (birds and reptiles), for the cochlea does not coil into a helix until we reach Mammalia. The tongue-like affair is simply as if a part of the first whorl of a mammal's cochlea very incompletely divided into *scala vestibuli* and *scala tympani* by cartilaginous structures representing a modiolus and its lamina, proceeding from the bony bar or bridge between *fenestra ovalis* and *fenestra rotunda*. These are the external (*a*) and in-

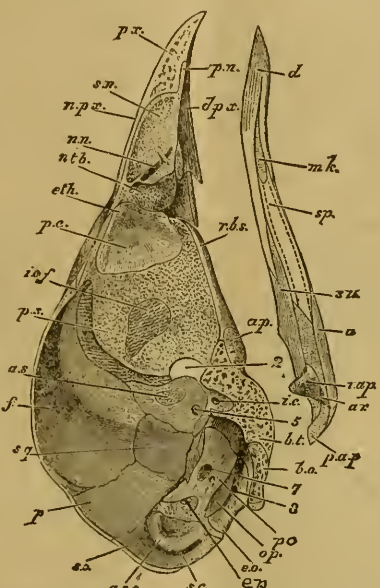


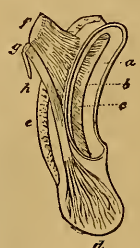
FIG. 4. — Ripe chick's skull, longitudinal section, viewed *inside*, × 3 diameters. (After Parker.) In the mandible are seen, — *mk*, remains of meckelian rod; *d*, dentary bone; *sp*, spleoial; *a*, angular; *su*, surangular; *ar*, articular; *iap*, internal articular process; *pap*, posterior articular process: in the skull, — *pn*, the original prenasal cartilage, upon which is moulded the premaxillary, *px*, with its nasal process, *npx*, and dentary process, *dpx*; *sn*, septo-nasal cartilage, in which is seen *nn*, nasal nerve; *ntb*, nasal turbinal; *eth*, ethmoid; *pe*, perpendicular plate of ethmoid; *iof*, inter-orbital foramen: *ps*, presphenoidal region; *2*, *optic foramen*; *as*, alisphenoid, with *5*, foramen for divisions of the fifth nerve; *f*, frootal; *p*, parietal; *so*, super-occipital; *asc*, superior semicircular canal; *sc*, a sinus (venous) canal; *ep*, epiotic; *eo*, exoccipital; *op*, opisthotic; *po*, pro-otic, with *7*, *meatus auditorius internus*, for entrance of seventh nerve; *8*, foramen for vagus nerve; *bo*, basi-occipital; *bt*, basi-temporal; *ic*, canal by which carotid artery enters brain-cavity; *ap*, basi-pterygoid process; *ap* to *rbs*, rostrum of the skull, being the parasphenoid bone underflooring the basi-sphenoid and future perpendicular plate of ethmoid.

ternal (*b*) cartilaginous prisms shown in figs. 8 and 9. The cochlea ends with a saccular part, termed the 'lagena.' Details of the soft parts — membranous, vascular, and nervous — will readily be made out from Professor Ibsen's beautiful figures, here reproduced (figs. 5, 6, 8, 9), with ample explanatory text.

The vestibule hardly requires special description, after examination of figs. 5 and 6. In the eagle, if its irregularities of contour were smoothed out, it would about hold a pea. Its utricular recess (*g*) is well developed.

In the language of human anatomy, the three semicircular canals are the anterior or superior vertical, the posterior or inferior vertical, and the external or horizontal; and the planes of their respective loops are approximately perpendicular to one another in the three planes of any cubical figure. In birds, these terms do not apply so well to the situation of the canals with reference to the axes of the body, nor to the direction of their loops; neither is their mutual perpendicularity so nearly exhibited. The whole set is tilted over backward to some extent, so that the anterior (though still superior) canal, *d*, in figs. 5 and 6, loops back beyond either of the others; its anterior limb is also straightened out. The posterior (though still inferior) canal, *f*, loops behind and below the horizontal one, *e*, which tilts down backward. The verticality of the planes of *d* and *f* is preserved. The canals in birds might be better known as the superior (*d*) and inferior (*f*) vertical, and horizontal (*e*); though it is not probable, viewing the great variation in the axes of this part of the skull, that any terms descriptive of *direction* will apply perfectly to all birds. Whatever its inclination backward, there is no mistaking *d*, which is much the longest of the three, looping high over the rest, exc[illegible] the petrosal, and partly bedded in the o[illegible], with the upper limb bas-relieved upon the inner surface of the skull (fig. 4, *asc*). The one marked *f* loops lowest of all, though little, if any of it, reaches farther back than *d*; it is the second in size, and quite circular (rather more than a semicircle). Its upper limb joins the lower limb of *d* as in man, and the two open by one orifice in the vestibule; but, as far as the bony tubes are concerned, it is not simple union, for the two limbs, before forming a common tube, twine half around each other (like two fingers of one hand crossed). The loop of *f* reaches very near the back of the skull (outside). The horizontal canal, *e*, is the smallest, and, as it were, set within the loop of *f*; its plane, the opposite of that of *f*. The bony cavities of *e* and *f* intercommunicate where they cross, at or near the point of their




Figs. 5, 6. — Membranous labyrinth of *Haliaetus albicilla*, × 2. *a*, *b*, cochlea; *b*, its saccular extremity (or lagena); *c*, vestibule; *g*, its utricle; *d*, anterior or superior vertical semicircular canal; *e*, external or horizontal semicircular canal; *f*, posterior or inferior vertical semicircular canal; *h*, membranous canal leading into aqueduct of the vestibule; *k*, vascular membrane covering the *scala vestibuli*. Opposite this, at *i*, are seen the edges of the cartilaginous prisms in the *fenestra rotunda*: from the edges of these cartilages proceeds the delicate membrane closing the opening of the cochlea (not shown in the figure).

Fig. 7. — Part of the superior vertical semicircular canal, showing its ampulla, nerve of ampulla, artery, and connective tissue of the perilymph, × 3. *a*, that part of the vestibule (alveus) next to the ampulla; *b*, the dilatation of the ampulla at its vestibular opening; *c*, where it passes into the canal proper; *d*, the canal, furnished with connective tissue of the perilymph along its concave border and sides, as appears clearly at the sections *e* and *f*; *g*, nerve of the ampulla; *h*, artery of the connective tissue, running beneath it, remote from the wall of the duct.

Fig. 8. — Cochlea, × 3. *a*, external, *b*, internal, cartilaginous prism; *c*, membranous zone; *d*, saccular extremity of the cochlea, or lagena; *e*, vascular membrane; *f*, auditory nerve, its middle fascicle penetrating the internal cartilaginous prism, to reach the membranous zone by its terminal filaments; *g*, auditory nerve, its posterior fascicle running to the most posterior part of the lagena; *h*, filament to ampulla of posterior or inferior vertical semicircular canal.

Fig. 9. — Section of the cochlea. *a*, vestibular surface of external cartilaginous prism, extending into *d*, the lagena; *c*, section of the membranous zone; *e*, Huschke's process of the fenestra, which, with the margins of the cartilaginous prisms, affords attachment to the blind sac, *f*, occluding the fenestra of the cochlea; *g*, spongy vascular membrane of the *scala vestibuli*; *h*, auditory lamellae of Treviranus; *i*, canals in posterior wall of the lagena, by which the nervous filaments enter its cavity.

(From Ibsen's Anatomiske undersögelser over örets labyrinth. Kjöbenhavn, 1881, p. 17, pl. 1, figs. 13–17.)

greatest convexity, farthest away from the vestibule. This decussation of *e* and *f*, like the twining inosculation of *f* and *d*, is well known. It may not be so generally understood that there is (in the eagle; I do not know whether or not in birds generally) a *third* extra-vestibular communication of the bony canals. My sections show this perfectly. The great loop of *d*, sweeping past the decussation of *e* and *f*, is thrown into a cavity common to all three. Bristles threaded through [illegible] the three canals can all be seen in [illegible]t, crossing one another through this curious extra-vestibular chamber. I call it the *trivia*, or 'three-way place.' It is just where, in fig. 6, the three membranous canals [illegible]ussate, — midway between the letters *e*, *f*, and c. It does not, of course, follow, that the contained membranous canals intercommunicate here, and it appears from Ibsen's figures that they do not. The ampullar dilatations of the ends of the canals are well marked. The anatomy of associate soft parts is explained to some extent under fig. 7.

The endolymph may contain otoliths similar to those great concretions called 'earstones' in fishes. The equilibrating function of the labyrinth and its fluid appears to have been determined mainly from experiments upon birds. The apparatus may be likened to the glass tubes filled with water and a bubble of air, by a combination of which a surveyor, for example, is enabled to adjust his theodolite true; for a bird somehow knows how the liquid stands in these self-registering levelling tubes, and adjusts itself accordingly. Observations made upon pigeons show, that, "when the membranous canals are divided, very remarkable disturbances of equilibrium ensue, which vary in character according to the seat of the lesion. When the horizontal canals are divided, rapid movements of the head from side to side in a horizontal plane take place, along with oscillation of the eyeballs, and the animal tends to spin round on a vertical axis. When the posterior or inferior vertical canals are divided, the head is moved rapidly backwards and forwards, and the animal tends to execute a backward somersault, head over heels. When the superior vertical canals are divided, the head is moved rapidly forwards and backwards, and the animal tends to execute a forward somersault, heels over head. Combined section of the various canals causes the most bizarre contortions of the head and body." — (Ferrier, *Funct. of the brain*, 1876, p. 57.) Injury of the canals does not cause loss of hearing, nor does loss of equilibrium follow destruction of the cochlea. Two diverse though intimately connected functions are thus presided over by the acoustic nerve, — audition and equilibration.

The wonderful and endlessly varied songs of birds may acquire for us a new significance, now that we understand the mechanism by which these engaging creatures derive pleasure from their own music. Though no two things can well be conceived more different than an anatomical disquisition and a bird-song, either may be made to subserve the purpose of a truer appreciation of the other; and there may be physiological aspects of even a 'Christmas carol.' Elliott Coues.

Washington, Christmas, 1882.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — I.

The general circulation of the winds is at times interrupted by local and temporary disturbances of very varied size and strength, to which the general name of 'storms' is given. Their most constant features are, a more or less pronounced inward spiral whirling of the air near the ground, feeding an up-draught at the centre, and an outflow above; and a progressive motion from place to place, along a tolerably well-defined track. Clouds, and generally rain as well, accompany the larger storms.

It is our object to explain how these disturbances arise, to examine the causes and methods of their peculiar action, and to study their distribution in time and place. With this end in view, the small dust-whirlwinds that commonly arise in the hot dry air of deserts will be first considered. Next will come the great hurricanes and typhoons of the tropical seas, and the less violent rotary storms of our own latitudes, all of which may be grouped together as cyclones. The tornadoes and water-spouts, showing a peculiar concentration of power over a very limited area, will be discussed last.

The dry whirlwinds in flat desert regions suddenly interrupt the calmness of the air, and begin turning, catching up dust and sand, and carrying them upwards through the spiral vortex to a height of many hundred feet. They are therefore not at all like those whirls formed about our street-corners at the meeting of opposing currents of blustering wind, or the eddies of greater strength seen in windy mountain regions; for they arise in a time of quiet, and begin their motion without apparent cause. Hence we must, at the outset, inquire into the

[1] Based on a series of lectures delivered at the Lowell Institute, Boston, in January, 1883.

condition of the atmosphere when it lies at rest, examining it especially with regard to the kind of equilibrium that then exists, and the changes necessary to produce a tendency to motion.

When the air is at rest, it is normally densest and warmest next to the earth's surface, and becomes thinner and cooler at successive altitudes above it. It is denser below because the earth's attraction pulls it down, and compresses the lower layers by the weight of the upper ones. It is warmer below, mainly because the air gets nearly all of its heat by contact with, or radiation from, the warm earth, and not directly from the sun's rays, which pass through it with but little obstruction. The average rate of upward cooling, determined by many observations on mountains and in balloons, is about one degree F. for every three hundred feet of ascent. In this restful condition let us take a block of the dry air (the effect of the presence of water-vapor will be considered with the storms at sea) from the earth's surface, where the temperature is, say, 60° (fig. 1), and lift it up three hundred feet, to where the temperature is one degree less, or 59°. The block of lower air expands as it rises, because it is pressed on by less atmospheric weight, — less, at least, by the weight of three hundred feet of air; and, in thus expanding, it is cooled mechanically. It has been shown that this mechanical cooling of an ascending mass of dry air amounts to one degree F. in a hundred and eighty-three feet of ascent, whatever its initial temperature; so that in this special case the block is cooled by 1.6°, and its temperature is reduced to 58.4°. Now, let us compare it, when thus expanded and cooled, with an equal-sized block of air beside it, whose temperature is 59°. Evidently, of these two blocks of the same volume, and at the same pressure, the cooler will be the heavier. The block brought up from the surface, and now at a temperature of 58.4°, will weigh more than the air at 59° beside it, and hence it will tend to sink; and it must sink all the way down to its original level before it finds any air as heavy as itself. In this imaginary experiment we have disturbed the arrangement of the normal, quiet atmosphere; and the disturbed mass returns to its original position as soon as freed from the constraining force. Such an atmosphere is therefore in a condition of stable equilibrium, like a rod hung by its upper end, which is opposed to any change in its position, and, when displaced, tends to return to its original attitude.

Fig. 1.

Evidently, when a whirlwind springs up in the calm air of a desert, as is so often the case, the atmosphere cannot possess this normal stability: for then there would be no temptation to any such disturbance; the air would prefer to stand as it is. Before the whirlwind can arise, there must have been a change to a condition of unstable equilibrium, in which the air, like a rod balanced on its lower end, is ready to move on small provocation; and we have now to look for the cause of this change. To be guided properly in the search, the conditions necessary and antecedent to the formation of the whirls must be examined. They are, that the whirls occur generally in level, barren, warm regions, in quiet air, and only in the daytime after the sun has risen high enough to warm the sandy ground, and the air next to it, to a rather high temperature. As the first and second of these conditions may be present at night as well as by day, it must, without doubt, be the heat from the sun that disturbs the quiet equilibrium into which the air tends to settle, and, by warming the lower layers, causes a departure from the ordinary stable condition of rest.

Let a case be supposed: the sun has warmed the lower air of the first example to a temperature of 90° (fig. 2), while the air three hundred feet above the desert sands has, in virtue of its diathermance, risen only to 70°; so that there is now a difference of twenty degrees between these two layers. If we here repeat the experiment of carrying a block of surface-air to a height of three hundred feet, it is again mechanically cooled 1.6°, so that its temperature is reduced to 88.4°; and now, comparing it with an equal volume of adjoining air at 70°, the latter is evidently the heavier, and therefore the block of air brought up from the surface, instead of tending to sink, as in the first case, tends strongly to rise farther, and continue the motion given to it. In other words, the air is now in a condition of unstable equilibrium: it is ready to upset and re-arrange itself. The lower layer may be compared to a film of oil balanced beneath a quiet sheet of water: a little disturbance would cause the two liquids to change places, and the oil would rise through the water, draining itself upwards.

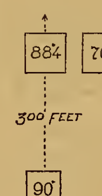


Fig. 2.

In such a condition as this, the desert-whirls may begin. It is clearly not necessary, in order to produce this result, that the vertical decrease of temperature should be as much as twenty degrees in three hundred feet, as in the case just assumed. In order to pass from the stable equilibrium, through the indifferent to the unstable equilibrium, it is sufficient, in dry air, that the vertical decrease should be greater than 1.6° in three hundred feet, or greater than one degree in one hundred and eighty-three feet. Moreover, it is important to notice, that, according to this theoretical explanation, the condition of indifferent equilibrium is passed before the surface-air is, as Franklin (1753) and Belt (1859) have said, specifically lighter than that above it. This would require a temperature difference of at least 5.6° F. in three hundred feet. It is sufficient that the surface-air shall be potentially lighter, though absolutely (before any motion takes place) heavier, than the higher layers, as Reye first showed (1864); or, in other words, stable equilibrium is lost, and indifferent equilibrium reached, when the surface-air is just enough warmer than any layer above it to make up for the change of temperatures produced in equalizing their densities. Any further excess of surface-warmth brings about theoretic unstable equilibrium. On the other hand, whirlwinds of decided activity will not be formed until the difference of temperature is much in excess of the narrow limits just given, the strength of the up-current increasing with its excess of warmth. Motion of the atmosphere caused by small differences of temperature would be very gentle, and would be perceived only in the 'boiling' of the air, often seen in summer-time over the brow of a hill.

It must be, then, the sun's heat, as was supposed, that destroys the normal stable equilibrium of our atmosphere; and to a disturbance of this kind we can refer more or less directly all storms, and, indeed, all winds that blow about the earth. Without the heat that is constantly showered down on us, we should soon gravitate into a lifeless condition of stable equilibrium, chemical, organic, and physical, and there remain in endless death. But the sun allows no such inactivity on its attendant planets: it keeps them alive and at work.

(To be continued.)

THE FRENCH ECLIPSE EXPEDITION.

P. J. Janssen, the leader of the French expedition which visited Caroline Island to observe the solar eclipse of May 6, has made a report to the French academy of sciences, which is published in full in the *Bulletin hebdomadaire de l'Association scientifique*, no. 181. It contains, first, an interesting account of the voyage to Caroline Island, and a brief description of the island, with the difficulties encountered in landing the instruments; then follows a statement of the instrumental outfit and the plan of observations. The search for intra-mercurial planets was assigned to Messrs. Palisa and Trouvelot. The former used an equatorial of 0.16 m. aperture, having a short focus and large field: the latter was provided with an equatorial of the same size, which had a finder of 0.08 m. aperture, thus giving the observer two telescopes. The finder had a field of 4°.5, and was used in examining the region in the vicinity of the sun, while the larger instrument was intended to give the position of any strange object that might be noted by means of its position-circles. In order to avoid the necessity of reading the circles, an attachment was made to both right ascension and declination circles, by which fine marks could be made upon the circles and verniers by the observer's assistants, and the corresponding readings determined at leisure. The finder was also furnished with a reticule containing cross-threads, and a position-circle for use in noting the appearance of the corona, to the drawing of which Mr. Trouvelot gave a portion of the time of the total phase.

The search for intra-mercurial planets was also conducted by the aid of photographic apparatus, which Mr. Janssen thus describes: —

"At my order, Mr. Gautier had prepared an equatorial mounting with an hour-axis two metres long, carrying a strong and large platform, upon which were fastened the following photographic apparatus: a large camera having a lens of eight inches (0.21 m.), made by Darlot, giving a field of 20° to 25° (plate of 0.40 m. by 0.50 m.), and designed for photographing the corona and the region about the sun with reference to the stars there found; a second camera, with a Darlot lens of six inches (0.16 m.), giving a field of 26° to 35° (plate of 0.30 m. by 0.40 m.), for the same purpose; and a very fine apparatus by Steinheil, for studying the corona. A second mounting carried several cameras with lenses of four inches (0.10 m.), giving a great amount of light, and designed to determine by very sensitive plates what are the limits of the corona, — an apparatus of great light-power, the exposure lasting during the whole of totality."

For spectrum analysis the following apparatus was employed: "a [reflecting] telescope of 0.50 m. aperture, having a very short focus (1.60 m.), and supplied with a direct-vision spectroscope of ten prisms; the slit of the spectroscope could be placed at different position-angles, and rapidly opened or closed, at the pleasure of the observer. An excellent finder, supplied with a reticule, was placed near the spectroscope, and distant from it by such an amount, that, when one eye had fixed upon some point of the corona in the finder, the other could obtain the spectroscopic analysis of this point." There was also attached to this telescope a biquartz polariscope by Prazmowski, and a spectroscope for showing Respighi's rings. A spare mirror of 0.40 m. diameter was carried as a reserve, but was not brought into use, as, by great care, the first was kept uninjured, in spite of the frequent rains and the moisture of the climate.

Mr. Janssen gives the following condensed report of his own observations, drawn up immediately after the observations, in accordance with the plan by which all the observers of the party were governed: —

"My observations were of two classes, — optical and photographic. The optical observations were principally designed to determine whether the coronal spectrum consists of a continuous spectrum as a background with bright lines, or if the Fraunhofer lines exist there generally (an investigation made especially with regard to the question of extra-solar cosmic substances). In 1871 I had announced, that, besides the hydrogen lines, I had established in the spectrum of the corona the presence of the *D* line and of several others.

"In the present eclipse I proposed especially to solve this question. By means of the optical arrangements above described, I have been able to determine that the basis of the coronal spectrum is composed of the complete Fraunhofer spectrum. The principal lines of the solar spectrum, especially *D*, *b*, *E*, etc., were detected so surely that there can be no possible doubt of this fact. I recognized, perhaps, a hundred lines.

"I recognized this composition of the spectrum, particularly in the lower or most brilliant portions of the corona, but not to an equal degree at the same distance from the moon's limb. The details of this will be given and discussed at a future time.

"I studied also the rings of Respighi. The rings did not appear uniform about the moon's limb, but presented peculiarities of structure which will be especially discussed in their relation to the question of the Fraunhofer lines.

"I studied also polarization, but devoted to it only a few moments, using the excellent biquartz polariscope of Prazmowski. The polarization was very well defined, and possessed characteristics already recognized.

"Before the observations, I made a preliminary examination of the corona with the naked eye, and with an excellent telescope by Prazmowski. This examination was for the purpose of guiding me in the subsequent observations.

"All these studies — study of the shape, spectrum analysis, Respighi's rings, polarization — were combined with the view of solving the question of extra-solar cosmic substances. We think that the discovery of the complete Fraunhofer spectrum in that of the corona considerably advances this question.

"*Photography.* — Two great instruments, containing eight cameras, had been prepared for studying the question of intra-mercurial planets, and that of the shape and extension of the corona. With regard to heavenly bodies in the vicinity of the sun, these photographs will require a minute examination; but, with respect to the corona, it can be said that the great power of several of the lenses used [that of eight inches (0.21 m.) and that of six inches (0.16 m.)], and also the length of exposure, permitted us to prove that the corona has an extension very much greater than that shown by optical examination, either with the naked eye or in my telescope.

"Several of our large photographs of the corona have great distinctness. They show important details of structure which ought to be discussed. The shape of the corona was absolutely fixed during the whole duration of totality."

The reports of Messrs. Tacchini, Palisa, and Trouvelot are not given, but are alluded to in the discussion of the results of the observations, which next follows. Mr. Janssen regards it quite improbable that any intra-mercurial planets exist, on account of the negative testimony given by Mr. Palisa, combined with that of Professor Holden of the American party. Mr. Trouvelot's conclusion is less decisive, but the observer wished to re-examine the region of the sky before coming to a final conclusion.[1] The author adds, "When we consider that the bodies discovered by Professor Watson in 1878 can be identified, within the limits of error to which the method employed by that astronomer is liable, with two stars in Cancer,[2] we arrive at the conclusion that it is to-day extremely improbable that there exists one or more planetary bodies of any importance between Mercury and the sun. Our photographs, although not yet completely examined, seem to lead to the same conclusion."

The duration of totality was found by Mr. Trouvelot to be $5^m 24^s.1$, by Mr. Tacchini to be $5^m 23^s$.

On the subject of the corona, Mr. Janssen thus writes: —

"*The corona.* — Mr. Tacchini's report shows that this skilful astronomer made remarkable observations at Caroline Island, especially with regard to the analogy between the composition of the spectrum of certain parts of the corona and the spectrum of comets. It was part of my plan to examine this correspondence, as is shown by a note drawn up by me long before the eclipse, and which I read to my colleagues when we compared our respective reports. It is a matter which ought to be verified with the greatest care in future eclipses. However, I leave to Mr. Tacchini the task of developing his observations.

"It will be seen from my report, that the principal object of my observations was to decide one point of the composition of the spectrum of the corona which

[1] Mr. Trouvelot observed, near the close of totality, a star which he describes as 'bright, and of a pronounced red color;' but, by some misunderstanding, its position was not recorded by the special attachments to the circles above described. Its position, therefore, cannot be determined, nor the question of its identification be positively settled. The observer announces (*Comptes rendus*, Sept. 17) that he has re-examined the region, and finds no star of the corresponding magnitude and color in the vicinity of the approximate position which he was able to assign to it. "Although," he adds, "the absence of a red star as bright as that which I observed in the eclipse seems quite naturally to lead to the conclusion that the body in question is no other than an intra-mercurial planet, yet as the most necessary elements, such as the position and a disk or a sensible phase, are wanting in my observation, I think I ought to suspend, for the present, my conclusions upon the probable nature of the body."

[2] First pointed out by Dr. C. H. F. Peters (*Astron. nachr.*, nos. 2253 and 2254).

has always seemed to me very important; viz., whether the light of the corona contains an important proportion of solar light. The result surpassed my expectation in this matter. The Fraunhofer spectrum, so complete as I witnessed it at Caroline Island, proves, that, without denying that a certain part is due to diffraction, there exists in the corona, and especially in certain parts of the corona, an enormous quantity of reflected light; and as we know, besides, that the coronal atmosphere is very thin, it must be that in these regions cosmic matter exists in the condition of solid corpuscles, in order to explain this abundance of reflected solar light.

"The more we advance, the more we perceive the complex nature of the regions in the immediate vicinity of the sun; and it is only by persistent and very varied observations, and an exhaustive discussion of these observations, that we can arrive at an exact knowledge of these regions. The great eclipse of 1883 has allowed us to take a step forward.

"*Photography of the corona.* — The result of the studies of the photographs will be given later; for they require a thorough examination, since they record many most interesting phenomena. I will simply say at present, that these photographs show a corona more extended than that given by telescopic examination, and that the phenomenon appeared well defined and steady during the duration of totality.

"*Luminous intensity of the corona.* — I had prepared a photometric measure, by photography, of the luminous intensity of the corona. This experiment showed that at Caroline Island the illumination given by the corona was greater than that of the full moon. The exact numbers will be given later. It should be noted, that this is the first time that an exact measure of the luminous intensity of this phenomenon has been made."

The remainder of the report gives an account of the return journey of the members of the expedition. They visited the volcano of Kilauea on the island of Hawaii, and passed a night in the crater on the edge of the lava lake. Mr. Janssen made some experiments, which, he states, "show some curious coincidences between these volcanic phenomena and those of the solar surface. I was able, also, to obtain the spectrum of the flames which issue from the lava, and to establish in them the presence of sodium, hydrogen, and the carburetted compounds." W. U.

THE HIMALAYAS.[1]

MY predecessor, Sir Richard Temple, selected for the subject of his address to this section last year, 'The central plateau of Asia.' Following him in a measure over some of the same ground, I have selected the mountain region south of the Central Asian highlands, viz., the Himalayas, and more particularly the western portion of that range, as the subject of this paper. I propose considering this mountain chain with reference to its physical features, past and present, and consequently with reference to its geological history, so far as that relates to later tertiary times; i.e., the period immediately preceding the present distribution of seas, land, rivers, and lakes. It is not, however, my intention to enter very deeply into the purely geological branch of the subject.

The Himalayas, the highest mountains in the world, comprise, strictly speaking, only the snowy range seen from the plains of India, bordering upon the course of the Ganges; but we might, I think, use the term in an extended sense, so as to include that which we may call the north-western Himalaya, north of the Punjab, and also the eastern Himalaya, bordering on Assam. The orography of this mountain mass has been recently ably handled by Messrs. Medlicott and Blanford;[1] and I follow them in all their main divisions and nomenclature, which are based upon a thorough understanding of the rocks of the country. Some line must be selected where the term 'Himalaya' must cease to be used, and this cannot be better defined than by the valley of the Indus from Attock to Bunji. On this line we find the great bending-round of all the ranges. To the mountains north of the Indus, on its east and west course, the name 'Himalaya' should certainly never be applied. For this north-west, trans-Indus part of the Asian chain we have the well-known name 'Mustagh,' so far as the head of the Gilgit valley; the 'Hindu Kush' being an excellent term now in common use for its extension to the Afghan country.

The observations made by many of the assistants of the Indian geological survey, more especially by Stoliczka, and more recently by Lydekker, in the Himalayas, combined with those made by myself in the same region, have, when considered in conjunction with the ascertained strike of the granitoid or gneissic rocks, led me to separate the great Central Asian chain into the following five principal divisions, with some minor subdivisions: —

1. The main or Central Asian axis, Kuenlun.
2. Trans-Himalaya.
3. Himalaya.
4. Outer or lower Himalaya.
5. Sub-Himalaya.

In our present ignorance as to the composition of the chain eastward from the Sutlej, we cannot attempt to lay down there any axis-lines of original elevation; but the separation of the line of highest peaks into one range, and the water-parting into another, is an acceptable solution of the physical features, as at present known, of this part of the chain. I think, however, that when this ground is examined, it will resolve itself into a series of parallel ridges, more or less close, and oblique to the line of greatest altitude as defined by the line of high peaks, crossing diagonally even the main drainage-line of the Sanspu; just as we see the Ladak axis crossing the Indus near Hanlé, or the Pir Panjal that of the Jhelum. Sir Henry Strachey's conception of the general structure was the soundest and most scientific first propounded.

[1] Abstract of an address by Lieut.-Col. H. H. GODWIN-AUSTEN, F.R.S., F.G.S., F.R.G.S., etc., president of the section of geography of the British association.

[1] A manual of the geology of India, 1879, p. 9.

He considered it to be made up of a series of parallel ranges running in an oblique line to the general direction of the whole mass, the great peaks being on terminal butt-ends of the successive parallel ranges; the watershed following the lowest parts of the ridges, and the drainage crossing the highest, in deep gorges directly transverse to the main lines of elevation.

We can, in a measure, exemplify the structure of the Himalaya by that of the bones of the right hand, with fingers much elongated and stretched wide apart, of which the wrist and back may represent the broader belt of granitic rocks of the eastern area; the thumb and fingers, the more or less continuous ridges of the north-west, some less prolonged than others to the north-west, such as the Chor axis, which may be represented by the thumb, terminating on the southern margin near the Sutlej. The left hand placed opposite will represent the same features to the west of the Indus. We will even carry this simile farther, and, as a rough illustration, suppose the intervals or long basins between the fingers to be filled with sedimentary deposits, and the fingers then to be brought closer together, producing a crushing and crumpling of the strata. At the same time, an elevation or depression, first of one or more of the fingers, then of another or of the whole hand, has taken place, and you are presented with very much what has gone on, upon a grand scale, over this vast area. As these changes of level have not taken place along the whole range from east to west in an equal extent, but upon certain transverse or diagonal lines, undulations more or less great have been the result; and some formations have attained a higher position in some places than in others, producing, very early in the history of these mountains, a transverse system of drainage-lines, leading through the long axial ridges.

The last efforts of these rising, sinking, and lateral crushing, and, as I believe, very slowly acting forces, are to be seen at the southern face of these mountains, in the tertiary strata that make up the sub-Himalayan axis (Sivalik), — a topographical feature which is most striking by reason of its persistence and uniformity for some 1,600 miles. From Assam on the east, to the Punjab on the west, bending round and extending to Scinde, this fringing line of parallel ridges is found at the base of the Himalayas; sometimes higher, sometimes wider, often forming elliptical valleys. Only in one part of the belt, east of the Teesta, are they absent altogether for a distance of fifty miles. These formations are of vast thickness, and, in the Punjab, cover an area of 13,000 square miles. The whole of this material has been derived from the adjacent Himalayas, and has travelled down valleys that have been excavated in pre-tertiary times. This points to a slow subsidence of the whole southern side of the mountain mass, deposition generally keeping pace with it, broken off by recurring long intervals of re-elevation.

The next most interesting feature connected with the former distribution of land and sea is that these sub-Himalayan formations are fresh-water, or torrential, showing that since nummulitic or eocene times the sea has never washed the base of the Himalayas. In fact, there is no evidence of this from the gorge where the Ganges leaves the mountains up to the base of the Garo Hills. I believe that from Assam to Scinde there once existed a great river, receiving its tributaries from the Himalayas, partly a land of lakes and marshes, the home of that wonderful mammalian and reptilian fauna which Cautley and Falconer were the first to bring to light. The southern boundary of this long alluvial plain was formed by the present peninsula of India, and probably of the extension of the Garo and Khasi Hills westward to the Rajmahal Hills. Depression has been considerable in the neighborhood of Calcutta, nearly five hundred feet. At three hundred and eighty feet, beds of peat were passed through in boring; and the lowest beds contained fresh-water shells. The beds, also, were of such a gravelly nature as to indicate the neighborhood of hills, now buried beneath the Ganges alluvium. This is precisely the appearance of the country above Calcutta, on approaching the present valley of the Brahmaputra. The western termination of the Garo Hills sinks into these later alluvial deposits; and along the southern face of the range, up to Sylhet, the waters of the marshes during the rainy season wash the nummulitic rocks like an inland sea, and point to the very recent depression of all this area. The isolated granite hilltops jutting up out of the marshy country from Dhoobri to Gwalpara, and on to Tezpur, all testify to the same continuous depression here. It is exactly north of this that we find the Sivalik formations, absent at the base of the Himalayas.

This gradual depression of the delta of the Ganges, the relative higher level of the water parting and shifting of the Punjab rivers westward, appear to be only the last phase of that post-pliocene disturbance which broke up the Assam sub-Himalayan lacustrine system draining into the Arabian Sea. Zoölogical evidence, which I cannot here find space to quote, is also in favor of this former connection of the now separated waters of the Ganges and Indus basins, and the hill-tracts of the Garo and Khasi Hills with peninsular India.

Within the mountains in the old rock basins — and these are analogous to the valleys of the Alps — are pliocene and post-pliocene beds of great thickness, but of fresh-water origin; the remnants of which are to be seen in Kashmir and Scardo at intervals, along the valley of the Indus, and that large, now elevated, accumulation at the head of the Sutlej River in Hundes, — all in the more sheltered portions of the valley basins, untouched by the denuding action during the glacial period. The extent and displacement of the upper pliocene beds in north Italy and here are very similar. Often abutting horizontally against the mountains, they are in other places found tilted at considerable angles on the margin of their original extension. When we examine their contents, we find that the fauna of that time, in Asia as well as Europe, was more African in character, and included the hippopotamus, crocodiles, and tortoises; of which, the common crocodile, the gavial or long-snouted species, and an Emys, have survived the many geological changes, and still inhabit the rivers and low grounds of India to-day. The fresh-water shells are the same now as then. Many species of antelope lived in the neighboring plains and uplands. The elephant was there in the zenith of its existence, for no less than thirteen species have been found fossil in northern India.

If we now turn to Europe to compare formations of similar age, Lombardy and the valley of the Po, with the southern side of the Alps, present to us somewhat similar physical features. A large area of about the size of the north-west Punjab, once a part of the miocene sea, is occupied by a remnant of rocks of that age, considerably elevated and tilted, but not to such an extent as those of the Himalayas. Near Turin these dip towards the mountains; and a very short examination shows the undoubted glacial character of some of the beds; and, as the whole formation is marine, their large sharply angular material, much of which is jurassic limestone, was probably transported from the adjacent mountains by the agency of ice in a narrow sea.[1] After the great crushing and alteration of the previous outlines of the whole country, another sea filled the basin of the Po, and pliocene deposits were laid down in a sinking area extending to the base of the mountains all round the new bay or gulf. Re-elevation again set in, and with it, or soon after it, the advent of another and the last glacial period.

Before the last great elevation of the alpine chain, the whole line of seacoast, therefore, ran even high up the long deep valleys of Maggiore, Como, Garda, etc. Then came the gradual but uneven elevation of the whole area, including the miocene hills south of the Po; and lacustrine and estuary conditions prevailed over much of the plain country. The lapse of time was probably enormous; and, as the land rose and the sea retired, the climate gradually became cooler, and ushered in the glacial period. With the change and the increased volume of the mountain torrents, the destruction of the upraised marine pliocene beds commenced, and finally culminated in the extreme extension of the glaciers, even into the plains. The denudation of this formation has been enormous along the base of the Alps, and only mere remnants are to be found. Their preservation is due to their being in position where the great denuding force, the ice, has been unable to touch them: in other instances the early deposition of moraine matter upon them has acted liked a shield, and prevented their entire destruction.

The scattered remnants of the pliocene formation south of the Alps show well how soon a great formation may be completely destroyed by denuding forces.

[1] No trace has been observed of this glacial period in the miocene of India. The most lofty portions of the chain had not then attained a greater elevation, probably, than 14,000 to 18,000 feet, and the outer axis-lines far less. However, in the tertiary beds (middle eocene?) of the Indus valley, below Leh, such conditions are indicated by Lydekker (*Memoirs of geological survey of India*, vol. xxii. p. 104, which I have received since this address was sent to press).

It is an established fact, that the great valleys of the Alps and Himalaya existed much in their present form during miocene times; and they may owe their excavation partly to the glacial action of that period, when these mountain slopes rose from the plain or margin of the ancient sea, far in front of the present line of slope, and were far higher than now.

It is not improbable, that, during the earlier extension of the glaciers into the Maggiore basin, the sea still had access to it. This would have greatly aided in the removal of the marine deposits, and then the deeper erosion of its bed near the Borromean Islands, so well put forward by Sir Andrew Ramsay. When we see the gigantic scouring which glaciers have effected in the hardest rocks on the sides and bottoms of valleys, when we know for certain the enormous thickness they reached in the Alps, I do not doubt for a moment their capability of deepening a rock basin very considerably, or their power to move forward over and against slopes so low as 2° to 3°.[1]

Passing from the glacial action displayed in the outer Alps to that in the Himalaya, we find ample evidence of a period of great extension of such conditions, first in the erratics of the Attock plain and the Potwar, lying fifty to sixty miles from the gorge of the Indus at Torbela. We have again the fact that in Baltistan, in the Indus valley, glaciers have twice descended far beyond their present limits, first down to Scardo itself, and then to some thirty miles below their present limits; while the glaciers of Nanga Purbet, towering above the Indus some 22,000 feet, must have descended into the bed of that river.

In fact, examples of the former extension of glaciers are wide-spread along the chain of the Himalayas from west to east. True moraines and moraine-mounds, at 16,000 feet on the north side of the Baralasa Pass, attest the presence of glaciers on the elevated plain of Rukshu, where now the snow-line is over 20,000 feet. Drew gives much valuable information regarding their former size. On the east, in Sikkim, Sir Joseph Hooker has described moraines of great height (700 feet) and extent. Still farther south and east, in the Naga Hills, a short period of greater cold is indicated by the moraine detritus under the loftiest portion of the Burrail range, in latitude 25° 30′.

Whatever may have been the length of the glacial period in the Alps, — and it was very considerable, — in the Himalayas it cannot have been so long and so general, although to a certain extent contemporaneous.

In the Alps, glaciation meets the eye on every side; and the mountains, up to a distinct level, owe their form and outline to its great and universal extension. In the Himalayas it is difficult to trace polished surfaces or striae markings, even in the neighborhood of the largest glaciers that are now advancing in

[1] There appears to be too great an advocacy, on the one hand, of ice-action having done all the work of denudation; while, on the other, some writers consider this to have been extremely limited. It is the combination of the two forces, I think, that effects so much, and in so different a manner and degree.

full activity. Although of such great length, these Himalayan glaciers could never have reached the enormous thickness which the earlier alpine glaciers attained.

Two periods of glacial extension are clearly defined, separated by a milder interval of climate. During the earlier glacial period the Indus valley was filled with those extensive lacustrine and fluviatile deposits, mixed with large angular *débris*, such as we see at Scardo, which may be coeval with the extreme extension of the alpine erratics, so far as the miocene hills south of Turin.

The second period followed after a long interval of denudation of the same beds, and would correspond with the last extension of the great moraines of Ivrea, Maggiore, Como, etc., followed by a final retreat to nearly present smaller dimensions. Nowhere on the south of the Himalaya do we find valleys presenting any features similar to those of the southern Alps, particularly on the Italian lakes, which are, I believe, the result, in the first place, of marine denudation, succeeded by that of depression, and finally powerful ice-action.

This attempt to bring before you some of the great changes in the geography of Europe and Asia must now be brought to an end. I am only sorry it is not in more able hands than mine to treat it in the manner it deserves, and in better and more eloquent language; but it is a talent given to but few men (sometimes to a Lyell or a Darwin) to explain clearly and in an interesting form the great and gradual changes the surface of the earth has passed through. The study of those changes must create in our minds humble admiration of the great Creator's sublime work, and it is in such a spirit that I now submit for your consideration the subject of this address.

FRENCH GEOGRAPHICAL EXPLORATIONS.[1]

SINCE the last re-union of our societies, we have seen the complete success of the French expedition to observe the transit of Venus. This phenomenon, important for astronomy, which requires a unity of measurement of the celestial spaces, should also be of interest to geography, for the unity sought is the correct distance of the sun from the earth. We already know the distance of the moon from the earth, about ninety-six thousand leagues, of which I can easily form an idea, as it is the distance I have traversed by land and sea since 1854, the time that I commenced my isthmus travels. "The French expedition sent to foreign parts to observe the transit of Venus has obtained a great and well-earned success, of which they are justly entitled to be proud." So says one of the most eminent French *savants*, Mr. Dumas, who has largely contributed to that success.

It now remains, and it is not the least difficult part of the task, to compare the results obtained, in order to submit to a delicate analysis the infinitesimal differences, which correspond to errors of hundreds of kilometres, in the distance sought. *Savants* have, it is true, more than a century to make use of the observations of 1882; for the phenomenon will not take place again till the year 2004.

At the extreme east of Europe we find in process of execution a work whereby modern science shall again assert her superiority by a success which the ancients gave up. Through the initiative of Gen. Türr, the Isthmus of Corinth is at this moment being cut, which will shorten by about two hundred and fifty kilometres, on an average, the voyage between the eastern and western parts of the north of the Mediterranean. In the course of the present year, the two plains at the side of the Gulf of Aegina and the Bay of Corinth will be cut away, and workmen will attack the solid mass of forty-seven metres, which it is desired to cut away to eight metres below the level of the sea. It is, *in minimo*, the cut of the Isthmus of Panama, the length of which is seventy-three kilometres instead of six kilometres; that is, double the distance between the garden of the Tuilleries and the Arc de Triomphe in the Étoile at Paris.

Some distance north of Corinth, there is unfolding another episode of the struggle between these two rival powers, the earth and man. There the work has begun which will transform a marshy lake into fertile plains. In a few years, broad Lake Copaïs will suffer the fate of Lake Fucino, Lake Fessara, Lake de Harlem, and the marsh of Pinsk.

There is still a fourth isthmus to cut. The king of Siam has authorized a survey for a maritime canal on his territory, between the Indian Ocean and the seas of China and Cochin China. The object is to escape the dangerous Strait of Malacca, and gain six hundred leagues from Europe to the extreme east.

In Arabia, Mr. Charles Huber, who two years ago successfully accomplished a mission for the minister of public instruction, has resumed the journey he made so fortunately; but he wishes to proceed farther than at that time he was able. At present he is at Palmyra, copying rare inscriptions; and, this completed, he will set out for Hall, for the Nedjed, and perhaps farther if circumstances favor his energy and firm will. The Arabian peninsula is one of the fields of study where French science has a long standing and very honorable record. We can but hope that Mr. Huber may show himself worthy of his predecessors.

In the extreme east, Cochin China and Tonquin have been most recently explored by the French, and I should like to recount the discoveries of Dr. Néis and Lieut. Saptans at the sources of the Donnaï. The former is at present *en route* for the region which he has already visited. Ethnography and anthropology, which are his special objects of study, will no doubt acquire new information, full and exact, from Dr. Néis's present journey. The study of the ancient civilizations and of epigraphy engages the attention of Capt. Aymonier, who has just finished a fruitful exploration at Cambodia. The parcels recently sent to the museum of the Trocadero testify to the importance of the results gathered by Mr. Aymonier, who is one of the most distinguished, perhaps the most distinguished, representatives of Indo-Chinese

[1] Address by FERDINAND DE LESSEPS before the geographical congress at Douai. Translated from *Cosmos-les-mondes*, vi. 91, 121.

students. Tonquin is known to us only by its delta, which has been an object for fine work by French hydrographic engineers. Beyond, to the right and left of the Red River, surveyed first by Mr. Dupuis, and afterward by Mr. de Kergaradec, we know nothing, or almost nothing, with certainty. Last year, in the face of dangers to which his companion Mr. Courtin succumbed, Mr. Villeroy-d'Augis made an examination which has given us the first rough sketch of the course of the Black River. The mineral resources of Tonquin, on the coast at least, have been ascertained by Mr. Fuchs in a recent voyage; and this distinguished engineer seized the opportunity to gather the first materials of the geological constitution of that part of Anam, as well as the rest of Indo-China. The events which are taking place at Tonquin we cannot examine; but they will lead, doubtless, to a state of things which will render journeys practicable. Mr. Harmand, who was conspicuous at the beginning of his career for his important explorations, will doubtless lend his co-operation to the French explorers who are about to set out for these parts of Asia.

If we turn our eyes toward Africa, we see several Frenchmen engaged in the contest which will definitely free this continent to science in opening it to civilization. For all Algeria the time of exploration, properly so called, is past. The country surveyed by geodesians is open to military topographers, who will give us a representation of it as beautiful and as correct as the map of France. At the instigation of our colleague, Col. Perrier, chief of the geographical service of the army, the surveys are being followed up, and the publication of the work will soon begin, to be continued without interruption.

For the extreme south of Orange, geography had only a series of isolated guide-books, with a few descriptions carefully made, but limited. Wars have drawn to this territory a troop of surveyors, whose campaigns have resulted in a survey, based on a triangulation, of all the country between Mecheria, the terminus of the Orange railroad, and the great oasis of Figuig. I certainly do not err in asserting, that the officers who have accomplished this difficult and dangerous work, Capt. de Castries and Lieuts. Brosselad and Delcroix, deserve well of geography.

In France the events in Tunis have been watched with much interest. Geography will gather the first fruits from these events. Here, again, we were reduced to information confined to the surroundings of Tunis, and certain points of the regency, and very estimable itineraries, but whose loose threads circumscribe vast regions left blank on the charts or timorously sketched. Following our exploring column, skilful surveyors have continued to fill up these gaps. Their records have been completed, and arranged methodically by officers attached to the geographical service of the army. If I am correctly informed, this service now possesses the materials for a large map, on which Tunis will appear in a decidedly new light, with the arrangement of its valleys, the character and projection of its prominence, and the precise position of its centres of population.

The minister of public instruction, on his part, has organized an expedition for the scientific exploration of Tunis. Already, from an archeological standpoint, important discoveries have been made on this ground, where exist the relics of several great civilizations. The learned work of Mr. Charles Tissot, the correspondent of the institute, formerly ambassador to London, will be, as far as concerns the Roman epoch, a fine and substantial introduction to the investigations undertaken. Our protectorate will revive the Tunis of the past, while it creates a Tunis of the future. Here is the opportunity to mention the scheme in regard to the interior African sea, rendered practicable by the perseverance, disinterestedness, and knowledge of Commander Roudaire. Other surveys, executed during this campaign by the engineers whom Capt. Henry leads, fill up the gaps in the previous works, complete the information regarding the banks of the Senegal or its tributaries, and prepare the route towards Bammakoo for the next expedition. This time a larger party must be sent out than on preceding expeditions, and they ought to advance farther. After having, while the road was making, removed, without striking a blow, the chief of Moorgoola, who was hostile to us, and after taking by assault the village of Daba, where advance was opposed, the column finally arrived at Bammakoo, Feb. 1; and, on the 7th, Col. Borgnis-Desbordes laid the first stone of the fort. From this first journey, under the direction of Capt. Bonnier, the surveyors, who included some experienced officers (Capt. Vallière, for instance), have brought back very complete results, extending over the ground between Kita and Bammakoo, and in the surrounding countries, Fooladoogo, Gangara, and Bélédoogoo. They have also contributed largely to the geography of a country lately only touched by a few explorers.

I do not know that you will agree with me; but I see, in these three expeditions of Col. Borgnis-Desbordes, a very interesting moral side. Let us imagine a handful of men setting out from Calais, to reach, in a certain time, the neighborhood of Vienna or Budapest: let that be the distance. You know the difficulties that were encountered. After a long journey in barges on the Senegal, it was necessary, under a burning sky, to make weary marches across districts covered with high grass or with thorny plants, and across calcined plains. They must scale steep acclivities, pass through innumerable swamps, slimy and malarious. They must venture through narrow paths on the sides of cliffs into defiles, — veritable Thermopylae, where a few might stop an army. After the departure, fever attacked the column, and each day claimed its victim. Nevertheless their courage did not fail. At times they were compelled to fight, and to the ravages of fever was added the fire of an enemy who could not be disregarded. Sometimes they stopped; but then they were obliged to work without relaxation in building a fort, for the season was advancing. Three times in succession our soldiers, under such circumstances, have penetrated to the heart of the western Soodan, led by a man hardened by bravery. He was commissioned to push to the Niger the line of stations which should establish our claims. He advanced straight to his object: the difficulties of detail discouraged him no more than the unforeseen disconcerted him, or than danger frightened him. Thus supported by officers worthy of their leader, and by soldiers full of devotion, he has accomplished his whole task. The little phalanx re-embarked on the Senegal, ragged, worn out, emaciated, and reduced more than a third; but they had nobly and simply performed a grand deed.

Before leaving the Senegal, I would not forget to mention the efforts of Dr. Bayol to contribute to the geographical knowledge of these countries. You may already see, on the map of Africa, very carefully prepared by Capt. Lannoix for the geographical service of the army, the line of travel which, in his preceding journey, Dr. Bayol followed between Timbo and Medina, in a country still unknown. At present he has just traversed more than three hundred and sixty kilometres in a country, also left blank, or nearly so, on the maps. Lieut. Quiquandon, his companion, gives us a survey of the line of march, which, retreating from the Niger, will join the line of march of the Austrian traveller, Lenz, on his return from Timbuctoo. This is an important paper for geography. Mr. Bayol has arranged so that, up to Ségala, the states through which he has passed have accepted the protectorate of France. Besides the treaties to this effect, he brings back collections which will contribute largely to the geological and zoölogical description of this zone of the African continent.

If, now, we turn farther south, as it were symmetrically with the Senegal and the Niger, we shall come to the Ogowé and the Kongo. Here, too, we find a man firmly resolved to secure for France a country worthy of her on the banks of the Kongo. Here Mr. de Brazza (for you all have recognized to whom I refer) is at work. As I speak to you now, he must be *en route* for the great river, the inhabitants of whose banks will, without doubt, gladly welcome back an explorer who was always full of justice and humanity toward them. It is said that difficulties exist between Mr. de Brazza and Mr. Stanley. The situation has, I think, been much exaggerated. Let us not forget that the origin of the enterprise to which Mr. Stanley devotes his energy is due to his Majesty the king of Belgium, and was formed for the purpose of sparing the travellers of all nations a part of the dangers of their enterprises. The generous founder of the International African association will certainly do all in his power to establish kindly relations between two of the most illustrious pioneers of civilization and of science. Besides, Mr. de Brazza would not falsify by his acts the words which he uttered at the last banquet of the Société de géographie, when he received from the hands of his fellow-explorers the French colors: "There, where I shall be commissioned," he said, "to carry the colors you present to me, they will be a sign of peace, of liberty, of science, and of commerce; they will be kind and compassionate with the weak and courteous, but firm with the strong." Let us, then, be patient. Let us not expect, that, under the present circumstances in equatorial Africa, evolution and progress can be very rapid. Let us also not forget that we owe all respect to the claims of our friends the Portuguese to certain regions bordering the Kongo.

I would not neglect to invoke your sympathies for the calm courage with which, in western Africa, on the route of the great lakes, Mr. Bloyet accomplished the mission placed upon him by the French committee of the International association. The travellers of several nations could tell us what protection they have received, what support, what counsels, they have obtained, from Mr. Bloyet. It is his courage which assists in the noble task of making the French name loved and respected by the natives of these hostilely inclined countries. Still nearer the lakes are our Catholic missionaries, some of whom have already given to geography useful data of the countries in which they are engaged. The same is being done, also, by French evangelical missionaries farther south, in the region of the Lessooto. One of them, Mr. Kurger, is busily at work, perfecting a map of the country. We hear little from Mr. Victor Giraud, who is proceeding in the direction of the great Lake Banguelo, south of which Livingstone died. Our best wishes accompany the young explorer, whose character, knowledge, and equipment warrant us in expecting much of him.

Before leaving Africa, I wish to mention one who has already proved himself a distinguished traveller. I refer to Mr. Georges Rexoil. He is engaged at the south in the large peninsula of the Comalis, which he has explored at the north with so great success. If he succeeds in penetrating into this unknown and formidable region, he will certainly garner a new scientific harvest not less rich than the preceding.

Allow me to approach America, and briefly speak to you of the cutting of the American isthmus between Colon and Panama. Two years have been spent in preparing the field of battle. The entire line is occupied by our workmen and machines. The director, Mr. Dingler, engineer-in-chief, who has just set to work our corps, has returned to Paris to report both his plans and his preparations to inaugurate the canal in 1888. In the course of this year, till July of the year following, he will each month remove from the cut a million cubic metres of *débris*, and from that date two million cubic metres a month, making twenty-four million a year. The enterprise will be finished during the following four years. I intend to visit this magnificent work early in 1884, and I hope that delegates from our geographical societies will accompany me. I must not leave Central America without respectfully referring to the successful perseverance with which one of the most devoted missionaries sent out by the minister of public instruction, Mr. Désiré Charnay, has explored the ruins of Yucatan. His researches and discoveries, together with his inferences, certainly throw unexpected light on the former obscurity of the American civilizations.

The feeling of sadness which we all experienced, on learning the terrible ending of the expedition of Dr. Crevaux, is still with us. Since then, only vague rumors have reached Europe in regard to this tragedy in the heart of South America. Mr. Thouar, a young French traveller, is now facing dangers of every description, in his attempt to discover the remains of our unfortunate countrymen. Gathering information, and supported by good will on all sides, he is making slow but regular advance. We can only hope that he will attain his object; while we do not ignore the dangers to which he so generously exposes himself in trying to penetrate, accompanied only by an interpreter, a country inhabited by Indians who overthrew the mission of Dr. Crevaux. Our warmest hopes for success go with him in his noble undertaking.

At the extreme south of America, at Tierra del Fuego, a French mission, established a year ago, has been commissioned, in accordance with the international programme, to make meteorological and magnetic observations. We look forward to the next return of the guard-ships, whose work, accomplished under the direction of Mr. Martial, commander of the Romanche, will form a valuable contribution to the physical geography of these parts.

Finally, after a successful expedition to the northern latitudes, in the polar seas, which, since the voyage of the Recherche, have scarcely seen the French flag, one of our countrymen, Mr. Charles Rabot, is at present continuing in Russian Lapland the investigations which he began in Sweden. The region which he includes still offers a vast field for geographical and geological study.

Such, my dear colleagues, are the chief means by which the advance of French geography, in its most active and most persistent form is disclosed. I might still speak to you at length, but we must not deserve the reproach of weaving for ourselves crowns; and, in the noble titles I have just recalled to you, we should see rather the obligations they place upon us than the satisfaction which they bring to our proper national pride.

LETTERS TO THE EDITOR.

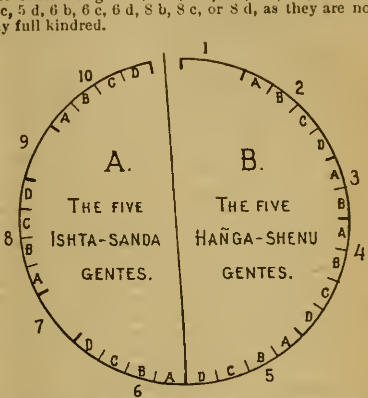
Marriage laws of the Omahas and cognate tribes.

THE Dakotas or Sioux still have mother-right in some of their tribes, and I cannot say how far the following statements apply to them; but the Omahas, Ponkas, Kansas, Osages, and others have father-right, and are governed by the principles here given, with one exception, — the Kansas have recently disregarded their laws, and have begun to marry in the gens.

The Omaha tribe is divided into ten gentes or clans, each gens having its special place in the tribal circle. In the figure the numerals denote the gentes, and the letters the sub-gentes.

Suppose that I belong to 1, the Elk gens, which is also my father's gens: I cannot marry any female of that gens. If my mother belongs to 2, a buffalo gens, I cannot marry any woman of that gens.

Suppose that my father's mother belonged to 3 a, my mother's mother to 4 a, my father's father's mother to 5 a, my mother's father's mother to 6 a, my father's mother's mother to 7, and my mother's mother's mother to 8 a: I cannot marry any women of 3 a, 4 a, 5 a, 6 a, 7, or 8 a, if I know of their relationship to me; but I can marry any women of the other sub-gentes, 3 b, 3 c, 3 d, 4 b, 4 c, 4 d, 5 b, 5 c, 5 d, 6 b, 6 c, 6 d, 8 b, 8 c, or 8 d, as they are not my full kindred.



I can also marry any women of 9 or 10, if they are not forbidden to me for other reasons; that is, if they are not my affinities, such as the wives (*real* or *possible*) of those whom I call my fathers, mother's brothers, grandfathers, sons, sister's sons, or grandsons.

Principles considered. — 1. Marriage in the father's gens forbidden. 2. Marriage in the mother's gens forbidden. 3. The regulation of the sub-gens. 4. Potential or possible marriages must always be kept in mind, and kinship terms are based upon them.

J. OWEN DORSEY.

Washington, D.C.

Francis Galton's proposed 'Family registers.'

Mr. Francis Galton is now planning to push his inquiries into the laws of heredity upon a more extensive and systematic scale than ever before. The success of his early work, 'Hereditary genius,' led him to observations in a wider field, which extended over several years, and were collected in his very valuable book, 'Inquiries into the human faculty,' which appeared last spring. His new proposal involves the collection of a large number of family biological histories, to extend over three or four generations, and to be obtained by circulating an exhaustive schedule of printed questions. The writer has just received a copy of the latter, together with a prospectus of the general plan, which Mr. Galton will call 'Family registers.' The revised schedules will shortly be ready for distribution. In the mean time an abstract of the prospectus and schedule may be given.

Mr. Galton foresees the difficulties which he will encounter; and, appreciating that the obtaining of accurate family histories of health and disease among laymen is almost out of the question, his prospectus appeals principally to the medical profession. Among doctors, all inherited disease is a disease, and not necessarily an hereditary disgrace, as most of the laity are apt to regard it. In this class, also, the scientific interest attached to inherited imperfections of physique or mind often overbears every other feeling. At all events, although the *anonymous* will be strictly maintained, Mr. Galton seems to expect that few non-professional persons will be ready even to put upon paper the rather searching register of replies.

The narrowest scope of inquiry, to be of any value, must embrace three generations; but the results will be far more reliable when they cover four. The latter would relate to at least thirty-six persons, which Mr. Galton reckons as follows: "On the side of the contributor there are his two parents, four grand-parents, an average of three uncles and aunts on each of the two sides, three brothers or sisters, and himself: this makes sixteen persons. There is another set of sixteen for the relatives of his wife in the same degrees. Lastly, I allow an average of four children." A single family register of this size, therefore, at least involves the filling-out of nearly thirty-six of the schedules, which will be no light task, even with the most favorable opportunities of obtaining information. The persons whom Mr. Galton anticipates will assist him the most are young physicians, married and with children. In case the grand-parents are living, their field of information will naturally be very wide. Partly as an inducement to men of this class to undertake such a task, partly as a pecuniary return for the time which it must necessarily occupy, a series of prizes will be offered, amounting, altogether, to £500, including, probably, ten prizes of £25 each, and others not to exceed £50 nor fall short of £5. The returns are to be sent with mottoes, but no signature; the name and address to be enclosed in a separate envelope bearing the motto. The merit of the returns will be estimated by the clearness and exhaustiveness of statement, the number of generations treated of, and the appendix (see beyond).

The returns asked for are in abstract as follows: 1. A separate and full biological history of each member of the family in the direct line of ascent; 2. A very brief statement of the main biological facts in the lives of members of the collateral lines of ascent, that is, of the uncles and aunts, great-uncles and great-aunts, etc.; 3. A full description of the main sources of information for 1 and 2; 4. An appendix which will include an analysis of the medical history of the family, showing the peculiarities which have, and have not, been transmitted, and their identical or changed form. All communications to be addressed to Francis Galton, 42 Rutland Gate, London (S. W.), England.

Mr. Galton has reduced the collection of statistics to a fine art, having arranged this schedule with the greatest ingenuity. The near and remote relationships are indicated by simple symbols; and, by means of horizontal and transverse columns, the required facts can be condensed into an astonishingly small space. Each schedule is intended to cover six periods in the life of the person described, from childhood to late in life, and at each of these periods to give a statement of, *A*, conditions of life; *B*, personal description; *C*, medical life-history. Under *A* are such topics as town or country residence, and sanitary influences generally. Under *B* are descriptions of feature and physique, of habits of work and muscular force and quickness, keenness of sight and dexterity, artistic and allied capacities, peculiarities of character and temperament. Under *C* are diseases, accidents, malformations, age at death, etc. Other facts solicited are, order of birth, age at marriage, number and sex of children. All this is upon one side of a double sheet, and relates to one person in the direct line of ascent. Upon the reverse of the sheet, similar inquiries are made in the collateral lines, or among the brothers and sisters of the person described.

Mr. Galton believes that the interest in each family register will increase rapidly as the investigation goes on, and family histories will result of far more accuracy than could be collected in any less methodical system. The scheme is so much more comprehensive than any thing which has preceded it, that it certainly promises us a much deeper insight into the laws of heredity than we have at present. The moral value of this, and, in fact, of much of the life-work of this author, lies in the dissemination of the stern truth, which is as old as the Mosaic law, that the character of the next generation depends, perhaps, less than we are apt to think upon the education and training we prepare for them, and more upon the life-conduct of the present and the preceding generations.

HENRY F. OSBORN.

MAUDSLEY'S BODY AND WILL.

Body and will: being an essay concerning will in its metaphysical, physiological, and pathological aspects. By HENRY MAUDSLEY, M.D. London, *Kegan Paul, Trench, & Co.*, 1883. 8+333 p. 8°.

CONSIDERED with respect to its announced purpose, this book is one of the most unfortunate and disappointing that we have ever seen bearing the name of an able man on the title-page. The purpose, as set forth on the titlepage and in the preface, seems indeed a noble one. Of will, in its pathological aspect at least, Dr. Maudsley has, one would suppose, the best possible right to speak. And we all have so much to learn about all its aspects, that we come to the book, even after previous experience of the author's eccentricities, with hope of getting some real instruction. That the freedom of the will is to be discussed, we learn without fear: for, old as the topic is, an ingenious man may have something new to say about it; and a straightforward statement of the doctrine of determinism, made from the physiological point of view, may well be useful and instructive, even if it should fail to be new. But, with much more interest than he feels in the promised wrangle over the freedom of the will, the student of psychology looks forward to what is promised in the preface, where Dr. Maudsley tells us that he has long been engaged in dealing with "concrete minds, that must be observed, studied, and managed;" that he has been trying to find out "why individuals feel, think, and do as they do, how they may be actuated to feel, think, and do differently, and in what way best to deal with them so as to do one's duty to one's self and them." In consequence, he says, "I have no choice but to leave the barren heights of speculation for the plains on which men live and move and have their being." He desires, then, "to bring home to mental philosophers the necessity of taking serious account of a class of facts and thoughts which, though they are not philosophy, may claim not to be ignored by philosophy." All this means, if it means any thing, that we may expect from Dr. Maudsley some results of his experience with the laws of human will, some concrete psychology, —such, for instance, as, in case of certain phenomena of sensation and memory, Mr. Galton has given us, in the book that we lately reviewed on 'Human faculty.' Mr. Galton's work has been confined mainly to the lower phenomena of mind. How great the gain, if we can get scientific research to give us correspondingly fruitful results about the higher phenomena of mind! We hope, of course, for nothing final, or as yet very exact, in this field: but Dr. Maudsley will surely offer us something; and his announcement is just such as a sober observer of a special class of facts might be expected to make, in case he had found out something well worth telling. As for the author's denunciation of speculation, we need not be haters of philosophy to overlook or pardon that. The most enthusiastic student of general philosophy ought to admit freely the vast importance to him, also, of just such concrete study of mind as Dr. Maudsley announces; and if Dr. Maudsley has found the heights of speculation barren, then surely he will keep off them, and will tell us what he has to tell so much the better. We reserve, then, our own right to study general philosophy if we find it fruitful; and we just now follow him eagerly to the green pastures of concrete psychology, where he is to give us the result of special study.

We are doomed to bitter disappointment. The book consists of three parts. The first, on 'Will in its metaphysical aspects,' fills ninety-eight pages, and contains a restatement of the bare commonplaces of modern thought on the relation of mind and organism, a like restatement of the oldest and most commonplace of the deterministic arguments, a barren criticism of the oldest and most commonplace arguments for free will, and finally, scattered throughout this discussion in all sorts of wearisome digressions, a string of purely speculative reflections, so confused, so full of contradiction, so ill expressed, that they would be unworthy to pass as the thesis of a fairly instructed student of philosophy in his second year's work.

The second part of the book (pp. 99–232, with four pages of notes) opens far more promisingly, with a good chapter on the 'Physiological basis of will.' But thereafter, at once the discussion sinks back into its native confusion. We are to learn about the 'physiological, sociological, and evolutional relations' of the will; and we have a series of the commonplaces of recent discussion, together with another mass of confused speculations, as full as before of digressions. Mr. Spencer, who is not named, is yet several times referred to very severely as a dangerous speculator; but the most obscure expressions of Mr. Spencer's worst moments are bright sunlight to the gloom of these long and tedious sentences, and his speculations are surely as likely to be good as his rival's.

The third part, at last, on 'Will in its pathological relations,' leads us into the light once more. Here, at least, we have a few concrete instances brought together, and generalizations made from facts, and plainly stated. But how little we learn! The space left is short; and the author's lucid interval ends with the beginning of the last chapter, which he entitles 'What will be the end thereof?' and which he devotes to speculations on the way in which human life will degenerate before its final cessation on this planet.

And so, of the whole, only about one hundred pages, or less than one-third of the book, may be considered as having any real relation to the implied promise of the preface. The rest is simply the 'barren speculation' which we were to avoid, or else it is repetition in obscure language of what has many times been said in clear language.

But we must illustrate, for we are aware that a man of Dr. Maudsley's reputation might be expected to do better than we have here represented him as doing. First, then, as to the 'barren speculation.' Surely, if a man desires to let questions alone, he can very easily do so. Yet Dr. Maudsley goes out of his way, in the first part, to write a chapter on the 'Authority of consciousness.' He goes out of his way, we say; for, in so far as concerns his problem of the freedom of the will, the authority of consciousness might have been very briefly and specially treated. But, once having determined to take up the question generally, Dr. Maudsley runs on in this wise. Self-consciousness, he first tells us, is no more immediate knowledge than is the knowledge of external objects through the senses; since the latter knowledge consists of states of consciousness, as well as does the former. This, of course, is Kant's famous 'Refutation of idealism' in a nutshell. But now, both of these kinds of knowledge being knowledge of facts that are in consciousness, we ask what the truth of this consciousness is, or how we shall test its truth. We learn something about this matter farther on, on p. 41, where we find that "there is no rule to distinguish between true and false but the common judgment of mankind," that (p. 42) "the truth of one age is the fable of the next," and that "the common mind of the race in me" — "common sense, which is more sensible than any individual in all cases (save in the exceptional case of a pre-eminently gifted person of genius)" — is the warrant to which we appeal for the truth of all our beliefs. This would look very much as if, in case one is not a pre-eminently gifted person of genius, one must be unable to know whether either he himself or the external world exists, unless he first discover that 'the common judgment of mankind' agrees with him that both do exist. This is a curious reversal of the familiar fashion of reasoning; since the 'mankind' to whom one is to appeal, surely belongs to the external world, to whose existence its 'common judgment' is to testify. Yet we must be doing Dr. Maudsley wrong. One must not take every statement so exactly. His real theory is expressed on p. 45. Here it is: "Every thing which we know is a synthesis of object and subject. . . . Neither *matter in itself* nor *mind in itself* are words that have any meaning. . . . The hypothesis of an external world is a good working hypothesis within all human experience: but to ask whether the external world exists apart from all human experience is about as sensible a question as to ask whether the shadow belongs to the sun or to the man's body; for what an extraordinarily perverse and futile ingenuity it is to attempt to think any thing outside human consciousness. . . . *To say there is an absolute* [the italics are ours], *and to call it the unknowable*, *is it a whit more philosophical than* it would be for a bluebottle-fly to call its extra-relational the unbuzzable?" P. 46 goes on to say, "A separation of subject and object cannot ever be the starting-point of a philosophy that is not a self-foolery." P. 47 adds, that what Berkeley called an idea "is a synthesis, the *ego* and *non-ego* necessary correlate." All this is perfectly clear by itself, much clearer than the text in which it is embedded; and the sense of it is, of course, pure phenomenism, such as Schopenhauer expressed in his '*kein objekt ohne subjekt.*' Matter is for consciousness, and consciousness is of objects. Spencer's unknowable is nonsense, — a product of perverse ingenuity, worthy of bluebottle-flies. One must not attempt to think of any thing outside of human consciousness; and so we have a doctrine.

No, not at all. Dr. Maudsley does not mean this. P. 51 is not far from p. 47; and yet, on p. 51, the author assures us that "the external world as it is in itself may not be in the least like what we conceive it through our modes of perception and forms of thought." On pp. 52 and 53, Dr. Maudsley outdoes this contradiction by bringing the two contradictories face to face on the same open page, and affirming them both at once with childlike simplicity. "I don't want to think the *thing in itself*. . . . If it is out of me, it does not exist for me, cannot possibly be more than a nonsensical word in any expression of me; and for me to think it out of me, as it is in itself, would be annihilation of myself." But all this, says Dr. Maudsley, teaches him that there *is* a great deal outside of his perception, 'a real world external to me,' of which, however, he can say nothing. So Spencer's rejected unknowable returns: the mind is necessarily obliged to think what it cannot possibly think, to believe in what it perceives to be nonsense, and to assert in one sentence that 'self and the world cannot be thought apart,' and, in the next sentence, that the real external world is so far beyond self that self is wholly unable to make any assertion, save that it exists.

Now, this is not a collection of statements found in various authors, and brought together by Dr. Maudsley for the sake of illustrating the 'barrenness' of the subject. On the contrary, these are his own views. He himself chooses to write a chapter on this topic. He is bringing home to the philosophers something that they need to know. He is dealing with "doctrines arrived at by the positive methods of observation and induction." If not, what does the preface mean? and what has the innocent reader done, that he should be trifled with in this intolerable way? But if in reality Dr. Maudsley is expounding doctrines arrived at by the methods of observation and induction, these doctrines ought not to change nature with every new paragraph. These statements are deliberate and repeated, they are made with much show of earnestness; and yet they are a series of contradictions, and leave the reader feeling as if some one had been trying to make a fool of him. As for this doctrine, that it is "perverse and futile to think of any thing outside of human consciousness" (p. 45), how does Dr. Maudsley venture thus solemnly to propound it and enlarge upon it, when elsewhere, and not far off, he repeatedly insists upon the view that human consciousness is inexplicable, save on the basis of an *unconscious* mental life, which can *never be exhaustively known* at all? Is the relation of author and reader one that involves no responsibilities?

Were not this confusion of statement typical, we should not insist upon it. But throughout the book one finds, if not always such flat contradictions, still a certain slipperiness and uncertainty about nearly every general doctrine that the author chooses to express, on all but the most concrete matters of fact. If he says a thing, you know not when or how soon he will withdraw it, wholly, or bit by bit. He thinks, for instance, that the belief in the vanity of all things, or pessimism, is a 'malady of self-consciousness,' a sign of mental decay; but he adds, that the 'central truth of all religions' is a conviction of the utter vanity of all things, and himself seems in great measure a pessimist. Pure Christianity teaches the noblest virtues, — those, for instance, of self-sacrifice; but the only test of virtue is the experience and common sense of mankind; and these teach us that pure Christianity, put in practice without stint, would render society impossible, since society depends upon conflicts and selfishness even now. The noblest virtues are therefore those that are rejected when the only test of virtue is applied. And so we are led on.

The same tendency appears in the very style of the book. When the author has a definite opinion, he likes to conceal it from you under manifold cloaks of language. He dislikes Spencer's doctrine, that organic evolution is 'progressive adaptation to the environment.' This, he says, is too vague and one-sided a statement. His own statement avoids all vagueness by saying that (p. 137) "an organism and its medium, when they have reached a certain fitness of one to the other and hit upon the happy concurrence of conditions, combine, so to speak, to make a new start, the initial step of a more complex organism;" that is, the organism evolves by evolution, and the evolution is caused by just those conditions that bring it to pass. Our author expands this thought, which he intends as an important complement to the doctrine of natural selection, over quite a number of pages. But that, in the famous words of the Duchess in Alice's Adventures, is not half so bad as our author can do if he tries. Religion he defines (on p. 208) as 'the deep fusing feeling of human solidarity.' Certain beliefs common among men are described (p. 198) as "the imaginative interpretations of an instinct springing into consciousness from the upward striving impulse which, immanent in man as part and crown of organic nature, ever throbs in his heart as the inspiration of hope." Thus our author knows of an instinct that springs from an impulse, which impulse is immanent in a crown, and at the same time strives upwards, and throbs in a heart as an inspiration. All this means, not mere carelessness of style, but a more serious error, else we should not have mentioned it here. It means haziness of thought: it means that our author can write many words in succession without knowing, in any adequate way, what they mean.

Our author's fashion of discussing things of which he is ignorant receives a crowning illustration in his last chapter; and, remote as the topic is from the main subject, we must mention this illustration here, because such matters are important to any student who is seeking a trustworthy guide. In this last chapter Dr. Maudsley has much to say of certain modern tendencies that he considers unhealthy. Of these, one is the excessive display of grief for the dead, which he thinks is growing among us. "Nobody of the least note dies but we are told with clamor of grief . . . that the most amiable . . . the best of men has been taken from us." But nobody, says Dr. Maudsley, is worth all this. "Contrast this modern incontinence of emotion with the calm, chaste, and manly simplicity of Homer; as we observe it, for example, in his description of the death of Achillès." Then follows a page of blank verse, which, of course, is offered to us as somebody's translation of the cited passage from Homer. Now, Dr. Maudsley was not obliged to say any thing about Homer, much less to quote him. He has gone out of his way to tell us, with an air of easily carried learning, what 'we see' in Homer. When a man thus pretends to quote the father of song, whose poems are at hand in all sorts of translations in any library, and to quote him especially for the sake of illustrating a certain important point, a reader supposes, of course, that the quotation will at least be a fairly accurate expression of something that Homer said. But, in fact, nothing resembling the passage quoted is to be found anywhere in Homer. These verses are not even so much as a remote imitation of any thing Homeric that bears upon Achilles. We ourselves are unable to identify them, but their tone is distinctly very modern; and we have little doubt that their author is now alive, or has very recently died.[1] But this is not all. To complete the blunder, Dr. Maudsley, in

[1] A classical friend, to whom we submitted Dr. Maudsley's quotation after we had written the above, assures us that the passage nearest to this one in ancient poetry is the death of Achilles as described in Quintus Smyrnaeus III., and that Quintus's description itself differs in so many important points from that of Dr. Maudsley's Homer as to make the latter not even a fair imitation of any ancient model.

this reference to Homer, has unwittingly chosen the worst possible illustration for his purpose, quite apart from his supposed quotation: for Homer does indeed tell us, in one passage (in the last book of the Odyssey), about the death of Achilles; but that passage informs us of a seventeen-days mourning of gods and men over the hero, with funeral ceremonies of extraordinary splendor, that would have done the dead man's heart good if he could only have been there to see. Nobody doubts Homer's simplicity, but Dr. Maudsley wholly misapprehends what it means. How he could have been so deceived in his quotation, we cannot guess; but such gratuitous blunders show us what to expect of a man that can make them.

If we have little space left to refer to our author's discussion of matters that he is eminently competent to discuss, that is not our fault. On the pathology of the will we receive instruction in the brief space before spoken of. Of heredity of mental disease we here find some illustrations, but we learn nothing new about the obscure subject of the actual laws that govern heredity. As to mental disease and its phenomena, Dr. Maudsley insists with considerable emphasis upon his view that the will, and in particular the most developed activity of the will, as seen in the moral consciousness of the civilized man, is the least stable, because the highest and latest element of man's mind, and must therefore show the signs of decay and disease soonest. This, he assures us, is actually the case. He illustrates his position by means of a good many instances of certain forms of mental disease. The view is not absolutely novel, and Dr. Maudsley has described most of the facts before. But all this is well worth telling, and would have made a useful essay if the rest of the book had reached the fire instead of the printer. As it is, this part of the book is the only one from which a student of such psychology as Dr. Maudsley so well describes in his preface can learn any thing of importance that is in any sense novel.

Our task in reading and reviewing has been no pleasant one. With Dr. Maudsley we hope for a psychology of 'concrete minds,' that may teach us "why individuals feel, think, and do as they do, how they may be actuated to think, feel, and do differently, and in what way best to deal with them so as to do one's duty to one's self and them" We see in the humblest experimental researches conscientiously conducted, in every observation of the mental pathologist, in every advance in nervous physiology, in every new discovery in animal psychology, and, let us freely add, in every fruitful philosophic research into the deeper problems of thought, in all these things, not only aids, but necessary conditions of the approach to the great end thus defined. But we also see in vague rambling disquisitions *de omnibus rebus*, such as nearly fill this book; in efforts at philosophy by a man who is confessedly and very manifestly unable to understand philosophic terms, who ignores the history of thought, and who insists upon writing pages of contradictory statements, — in all this we see, not advance, but serious injury. And when not only the book is such as it is, but also the author is a man whose position and previous services command respect, and who is therefore able to call the attention of busy students to whatever he may choose to publish upon the subject, — then we say that such conduct is a serious breach of the privileges of authorship, and we wish to raise a decided protest against it. For the rest we have no quarrel with the author's determinism, nor with his materialistic basis for mental science, so long as he confines both the doctrines to their only proper sphere; that is, employs them as regulative principles in discussing and explaining the facts of experience. We quarrel only with his confused and purposeless fashion of discussion.

NOTES AND NEWS.

— THE report of the committee of the Geodetic association was presented at a general meeting of the conference, Oct. 23, at Rome, and was adopted after an animated debate. The report favors the universal adoption of the Greenwich meridian, and also recommends, as the point of departure of the universal hour and cosmopolitan dates, the mean noon of Greenwich. The conference hopes, that, if the whole world agrees to the unification of longitudes and hours by accepting the Greenwich meridian, England will advance the unification of weights and measures by joining the metrical convention of 1875. The government of Italy will be requested to officially communicate the foregoing action of the conference to all nations.

— In the October number of the *Harvard university bulletin*, further instalments are given of the geographical index to the maps in *Petermann's mittheilungen*, by Mr. Bliss, and of Mr. Winsor's 'Bibliography of Ptolemy's geography,' containing important notes on early American cartography. Mr. Winsor also commences an account, of which six pages are printed in the present number, of the Kohl collection of early maps in the Department of state at Washington, prefacing it with a brief account of Dr. Kohl's labors.

In the official portion of the bulletin, we find the following appointments gazetted: Arthur Searle as assistant professor of astronomy; Robert H. Harrison, Harold Whiting, Charles E. Faxon, and Edward Burgess, instructors in anatomy, physics, botany, and entomology, severally; O. W. Huntington, assistant in chemistry, G. T. Hartshorn in organic chemistry, and G. W. Perkins in biology; and Dr. C. S. Minot, lecturer in embryology. The establishment of ten fellowships in the Lawrence scientific school, with an annual income of five hundred dollars each, is recommended by the corporation.

— The subjects to be presented at the Society of arts of the Massachusetts institute of technology the coming season will embrace a wide range of scientific and practical topics, arrangements having already been made as follows: —

Oct. 11, Professor Edward S. Morse of Salem spoke on Japanese pottery; Oct. 25, Professor William H. Brewer of New Haven read a paper on the evolution and breeds of domestic animals, as illustrated in swine; Nov. 8, Mr. Thomas Gaffield of Boston will read a paper on glass and glass-making.

At the subsequent meetings, the arrangements for which have not yet been definitely made, Dr. Charles S. Minot of the Harvard medical school will probably speak on some biological subject; Capt. D. A. Lyle, U.S.A., on the rise, progress, and methods of the U. S. life-saving service; Mr. Chauncey Smith of Boston, on the influence of inventions; Mr. R. B. Forbes, on the rigging of ships; and Major C. W. Raymond of the U.S. engineers will speak on Boston harbor. Various mechanical contrivances of interest will also be exhibited.

— A very valuable work on German meteorological bibliography has been prepared by Dr. Hellman. It contains a bibliography proper, limited to German authors, and also historical notices upon meteorological observations, and the progress of the science in that country.

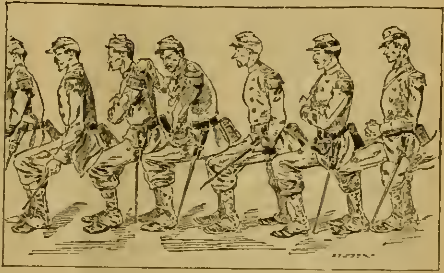
— A free course of popular lectures upon zoölogy, specially intended for teachers and students, will be given by the Cincinnati society of natural history on Friday evenings, commencing to-day. The following is the programme: Oct. 19, Introduction, The study of zoölogy, by Prof. J. Mickleborough; Oct. 26, The human skeleton as compared with that of other animals, by Prof. J. Mickleborough; Nov. 2, The trochilidae, or humming-birds, by Charles Dury; Nov. 9, Fish fauna of Cincinnati, by Dr. D. S. Young; Nov. 16, Comparative anatomy of the mollusca, by Prof. A. G. Wetherby; Nov. 23, The mollusca from an evolutionary stand-point, by Prof. A. G. Wetherby; Nov. 30, Some curious insects, by Charles Dury; Dec. 7, Practical manipulation of the microscope, by Dr. J. H. Hunt.

When this is completed, a second course of equal length will be given on geology and mineralogy, the special topics of which will be announced later.

— Active movements are making to supply, as far as possible, the losses sustained by the Indiana state university in its recent fire. When the first meeting of the board of trustees was held, about a week after the fire, Monroe county was prepared to guarantee fifty thousand dollars; and this, with over twenty-seven thousand dollars' insurance, gave the officials great confidence. No definite action, however, was taken, until a recent meeting of the trustees at Indianapolis, when it was decided to purchase a larger tract of land, just east of the city of Bloomington, much more favorably located than before, and to erect at once two fire-proof buildings, one of which can be used for the present for the literary department, and the other for the scientific department, museum, and library. Later, another building will be added, to which the literary department will be transferred, when the scientific department will occupy one of those now to be built, and the other will be given wholly to the museum and library.

For the present the university will occupy the old building, which was saved. It is reported that the trustees have in view the purchase of some valuable collections and a good library.

— A correspondent of *La Nature* gives a sketch, which we reproduce, of a group of French soldiers, as they appeared when resting on their marches in Algeria, when they were obliged to stop on marshy land, and had nothing upon which to rest. The soldiers seated themselves each on the knees of the one behind, and were arranged in a circle, so that there was no end man. The correspondent vouches for having often seen the operation. *La Nature* recommends the collegians to try the experiment in equilibrium when they return from their vacations, — advice which it would hardly do to transmit to Americans.



— Trouvelot has made an examination of the sky near the place of the sun at the May eclipse, for the purpose of rediscovering, if possible, the red star which he saw at that time, and suspected to be an intra-mercurial planet.

In the re-examination, he used a telescope of the same aperture and power as at the eclipse. He found again, without trouble, his two 'white stars,' and identified them as forty-one Arietis and ε Arietis. As to 'the brilliant star of a pronounced red,' he says he could not find it, and that it is certain that no star of that magnitude and color now exists near the position assigned, nor even within a distance much greater than it is permissible to attribute to the probable error.

At the same time, seeing he failed to obtain a determination of its position, or to notice any disk or phase, he considers it only right to reserve any conclusion as to the probable nature of the object (*Comptes rendus*, Sept. 17). Astronomers generally will be disposed to believe, with those who observed the eclipse at the same station with M. Trouvelot, that his limits of probable error were, under the peculiar circumstances, some of which are mentioned in his original report, much larger than he seems disposed to admit, and quite extensive enough to include the star α Arietis, which was not far from the place he assigns, and in magnitude and color corresponds well with his description.

— The department of entomology, of the New-York state museum of natural history, issues a circular (no. 1) giving directions for 'arresting the chinch-bug invasion' of northern New York, with good figures of the insect enlarged and of natural size.

— Wood sections and vegetable tissue was the subject discussed by Mr. J. F. Whiteaves at the meeting of the Ottawa microscopical society, Oct. 16. Mr. Whiteaves was elected president, and Dr. R. J. Wicksteed secretary, for the ensuing year.

— Among the prizes given to American exhibiters at the International fisheries exhibition just closed, at London, gold medals were awarded to G. Brown Goode, for work on ichthyology; D. S. Jordan, for work on ichthyology; Alexander Agassiz, for work on ichthyology; J. E. Hilgard, for optical densimeter; Capt. C. Sigsbee, U.S.N., for deep-sea sounding apparatus; W. L. Bailee, U.S.N., for deep-sea thermometer c silver medals to G. Brown Goode, for publications relating to the fisheries; Marshall McDonald, for universal hatching-jar; Lieut. Z. L. Tanner, U S.N., for deep-sea sounding apparatus; W. G. Farlow, for collection of marine algae; J. H. Emerton, for model of squid and octopus; T. H. Bean, for works on ichthyology; Marshall McDonald, for map showing shad fisheries: and diplomas to J. E. Hilgard, for salinometer; Capt. C. Sigsbee, U.S.N., for parallel ruler.

The United States receives 48 gold medals, 18 of which go to the fish-commission, mostly on collective exhibits, 47 silver medals, 29 bronze medals, 24 diplomas, and 7 special prizes. Other gold medals are to the national museum, for collective exhibit of fishes; signal-service, for most complete collection of apparatus for weather prediction; and lighthouse board.

— The French government has just issued a geological map of Algeria in five sheets, scale of 1:800,000, with two explanatory memoirs. This work is only preliminary; and appropriations have been made to organize a geological survey, which will make a careful and detailed geological map, first on the scale of 1:400,000, and then on a larger one, say 1:80,000, or even 1:40,000. The directors are A. Pomel, J. Pouyanne, and J. Tissot.

— Col. A. Parnell, R.A., states (*Journ. sc.*, September), that, as recorded by official returns, the number of persons killed by thunderbolts in Russia (not including Poland and Finland), in the five years from 1870 to 1874, was 2,270, of whom no less than 2,161 were dwellers in the country; and that during this period, in the same area, 4,192 fires were occasioned by thunderbolts, 4,090 of them being in the country.

— The speeches of Sir Lyon Playfair and Sir Charles Dilke, during the recent debate in the House of commons on the vaccination question, have been published by Messrs. Jarrold & Sons in pamphlet form, under the title of 'Facts about vaccination.' It is hoped that this little publication may prove a useful antidote to the present mischievous and ignorant agitation against Jenner's great discovery. The Clothworkers' company, one of the old London guilds, has devoted a fund at its disposal for the encouragement of research to offering a prize of a thousand pounds for the discovery of a method of procuring lymph that would obviate the present objections.

— At a recent meeting of the Société d'encouragement pour l'industrie nationale, M. G. Meyer of Paris submitted specimens of paper specially manufactured to resist fire. It was stated by him that the papers and documents shown had been for four hours in a retort in a pottery furnace; and it is further affirmed, that those present were unable to distinguish, either by appearance or texture, the papers so treated from others which had not undergone the ordeal of fire. "From experiments made with a specimen of wall-paper sent us," says a writer in *Iron*, "we are enabled to say, that, although the appearance of the paper does change, the fire-resisting properties claimed for it are undoubted: the paper certainly does not ignite." The paper can be made of a quality suitable for deeds and other important documents, or of a quality suitable for wall-paper, theatrical decorations, or, in fact, for any purpose for which paper is used. Mr. Meyer has also invented an incombustible ink and incombustible colors. Artists using those colors may preserve their works to a certain extent. The invention would appear to be of the greatest value to theatrical managers. By using thick cardboard of Mr. Meyer's material, together with his paints, they are able to render their scenery uninflammable. At the same time, for documents of importance, — deeds, wills, and agreements, — the invention should come into universal use.

— The catalogue of the Miller manual labor school was issued recently, bearing date of June, 1883. It is a neat pamphlet of some thirty pages, printed by the boys of the school. The school is situated in Albemarle county, Va., and was founded by the late Samuel Miller of Campbell county, who left property to the value of more than one million of dollars, to be expended in the erection of buildings, and the endowment of a school in which the students are to be instructed in the branches of a 'good, plain, sound, English education,' in ancient and modern languages, and in the useful arts. The school is now in operation, and a considerable number of students are in attendance, who are not only taught, but are fed and clothed, at the expense of the fund, which yields an income of sixty or seventy thousand dollars a year. Every student works in the shop, in the printing-office, on the farm, or in the garden. The workshop is built from the plans of Mr. M. P. Higgins of Worcester, and a class of twenty-five boys is making good progress. The farm comprises eight hundred and fifty acres, of which a hundred and twenty are fine, rich bottom-lands in the valley of Mechum's River. The farm last year yielded an income of four thousand dollars. Boys are received at from nine to fourteen years of age, and are kept until eighteen.

— The White Mountain club of Portland held their autumn meeting, Oct. 17. The president (Rev. Dr. Thomas Hill) narrated his labors in identifying a mountain seen from Portland, and hitherto taken for the Imp. He finds it is a part of Carter range: the true Imp is scarcely visible. Still another 'Imp' is seen from Copp's house, near the Glen and Gorham road, where it is pointed out by stage-drivers, etc., as the south-west side of the true Imp. Cline's map correctly locates this as another peak.

— The collections of plants made by the late President Chadbourne, comprising thirty-four distinct lots, and containing among them some of interest and value, are offered for sale by his executor, A. Schenck, 30 Union Square, New York.

— Herr Hugo Zöller, who visited the Isthmus of Panama and the South-American states as correspondent of the *Cologne gazette*, has published his experiences in two books, the first called 'Der Panamakanal,' in which he contradicts the too favorable reports spread in the European papers as to Mr. Lesseps' work on the canal, and says his company has too little capital to accomplish the undertaking. He gives a map of the district, and fully expects to see the water-way a fact, and not an idea, within ten years, but not through Mr. Lesseps' means. The second book concerns Brazil, and is called 'Die deutschen im brazilianischen urwald.'

— T. W. Blakiston contributes to the *Japan gazette* of Sept. 8 an account of a voyage across the North Pacific, in the ship Undaunted, from Yedo to Victoria, V.I., between May 20 and June 21, 1883. Temperatures, winds, etc., were carefully noted, and the author came to the conclusion that the Kuro siwo at that season disappears between latitudes 37° and 39°, and west from east longitude 154°. Eastward from this point nothing was seen of warm water referable to that current.

— In a paper recently read before the Geographical society of the Pacific, some remarkable statements were made in regard to the Mahlemuts of Norton Sound, Alaska. Among other things, if correctly reported, the author stated that 'their customs and part of their language resemble the Chinese greatly.' The Mahlemuts are an ordinary small tribe of western Eskimo, who have been studied by a number of ethnologists, and in no respect differ from the other Eskimo tribes of the region. Such wild statements, especially when made before a scientific society, are almost invariably reproduced in European journals, and for that reason should be noticed and corrected.

— J. G. Swan, who has been investigating the Queen Charlotte Islands, returned to Victoria, Sept. 27. He discovered a fine deep-water fish, which is new to the food-supply of the coast, and is said to occur in large numbers. He also reports finding a good harbor hitherto unknown.

— The volume of Washington astronomical and meteorological observations for 1879 has just been received at the naval observatory from the government printing-office, and will be distributed to correspondents immediately.

— A third edition, enlarged and improved, of Paetel's useful catalogue of mollusks, is announced. Though by no means available for text-book purposes, and with the usual allowance of errors, this publication cannot fail to be useful to all who have a large collection of shells to arrange, if it were only to furnish a workable foundation.

— The Iowa academy of sciences met at Ames on Sept. 27. Prof. C. E. Bessey of Ames read papers on the hybridization of Spirogyra majuscula and S. protecta; the effect of frost on leaf-cells, and on certain insect-catching glands on a grass. The glands referred to in the last paper are located on the blossom stems of Sporobolis, and secrete a viscous fluid, in which insects are entrapped. Their utility in these plants seems difficult to understand. In reply to a question by Professor Stalker, whether they could protect the blossoms from injurious insects, Professor Osborn said he thought they might possibly give protection from Cecidomyiae. Professor Herrick of Grinnell described a water-still for obtaining a constant supply of distilled water in laboratories, and offered some observations on the Grinnell tornado, tending to show that at that point the tornado formed a loop in its course. Prof. H. Osborn of Ames offered some additions to the list of Iowa insects, in Lepidoptera, Coleoptera, Hemiptera, and Neuroptera; notes on Mallophaga, taken in Iowa; and a paper on an epidemic disease attacking Caloptenus differentialis. This last is a disease similar in nature to that caused by Entomophthora muscae in the common house-fly, and very fatal to these locusts. It is caused by a species apparently new, and shortly to be described by Professor Bessey in the *American naturalist*.

— The third and fourth parts of volume xiv. of the *Archiv für anthropologie* contain three original papers, as follows: on Hypertrichosis, by Dr. Ranke; on the eyes of the Fuegians, by Dr. Seggel; and on copper in ancient times, by Dr. Reyer. Reviews of the anthropological literature in Russia are prepared by Dr. Stieda; in Scandinavian literature, by Miss Julia Mestorf; in American literature, by Dr. Emil Schmidt. The last named covers twenty-three closely printed quarto pages, and embraces about every paper of importance published in our country during the last year, relating to anthropology. The bibliography occupies 161 pages, and many of the titles are accompanied by a brief note stating the purpose of the publication. It is a thorough piece of work, and is distributed as follows: archeology and priscan history (*urgeschichte*), by J. H. Müller, 41 pages; anatomy, by Dr. Pausch, 6 pages; ethnology and travels, by Dr. Albrecht Penck, 90 pages; zoölogy in relation to anthropology, by Dr. George Boehm, 23 pages.

Students in all branches of science know how difficult it is to find the thing they are seeking. Between those piled up and stowed in great collections and those hid away in private museums, much time is wasted. Now, the anthropologists of Germany long ago felt the necessity of publishing the catalogues of the specimens in their great museums; and already have appeared five of these in former numbers of the *Archiv*. The current number devotes 36 pages to the Senckenberg museums in Frankfort-a.-M., with tables of measurements and descriptions; and 25 pages to the anthropological collection in the Grossherzoglichen naturalien-cabinets im alten schlosse, in Darmstadt, also with measurements and descriptions. Comparisons, of course, are always odious; but it cannot fail to strike our American anthropologists that the especial merit of the German system, that is, co-operation, is wanting with us. It may also be mentioned that none of the foreign anthropological societies seem to know any thing about the work in progress at the surgeon-general's office at Washington.

— There have been issued by the government, under the direction of Gen. W. B. Hazen, chief signal-officer, the meteorological and physical observations on the east coast of British America, by Orray Taft Sherman, as no. 11 of the 'professional papers.' Nos. 8 and 12 consist of papers on the 'Motions of fluids and solids' and 'Popular essays on the movements of the atmosphere,' by Prof. W. Ferrel; the first edited, with notes, by Mr. Frank Waldo. No. 9 contains charts and tables showing the geographical distribution of rainfall in the United States.

— The new British patent law will go into effect Jan. 1, 1884. The patent fee is reduced to about a hundred dollars for all fees, including agents' ordinary charges. Provisional protection is extended to nine months. Annual taxes are substituted for the stamp-duties now charged, although no change has been made in the total amount. The new provisions apply to applications now in the office. No change has been made in regard to examinations. The patent is issued to any applicant who chooses to pay the fees, and without formal examination. A system of comparison of the patent claim with the claim for which provisional protection has been granted, is, however, established, — a commendable innovation, and one which might well be supplemented by the system of complete examination practised in the United States. The duration of the patent is to be fourteen years in all cases, irrespective of the expiration of earlier foreign patents on the same device. The publication in Great Britain of the foreign specification of the invention does not, under the new law, invalidate the British patent. The new law will evidently greatly favor the inventor, and the change will be likely to prove to be very greatly to the advantage of that country as well.

RECENT BOOKS AND PAMPHLETS.

Bodländer, G. Das optische drebungsvermögen isomorpher mischungen aus den dithionaten des bleis und des strontiums. Inaug. diss. Breslau, *Köhler*, 1883. 34 p. 8°.

Edwards, Emory. Modern American locomotive engines; their design, construction, and management: a practical work for practical men. Philadelphia, *Baird*, 1883. 383 p., illustr. 12°.

Houston, Edwin J. The elements of chemistry; for the use of schools, academies, and colleges. Philadelphia, *Eldredge*, 1883. 444 p. 12°.

Johonnot, J. A natural history reader, for school and home. New York, *Appleton*, 18+414 p., illustr. 12°.

Ladenburg. Handwörterbuch der chemie. band 1. illustr. 8°.

Planteau, H. Développement de la colonne vertébrale. Paris, 1883. 116 p., illustr. 4°.

Pouy, F. Les anciennes vues d'optique. Amiens, *impr. Jeunet*, 1883. 39 p. 8°.

Rochebrune, A. T. de. De l'emploi des mollusques chez les peuples anciens et modernes. i. Amerique. livr. 1. Paris, *Leroux*, 1883. 23 p. 8°.

Rohde, E. Beiträge zur kenntniss der anatomie der nematoden. Inaug. diss. Breslau, *Köhler*, 1883. 26 p. 8°.

Routledge, R. Discoveries and inventions of the 19th century. London, 1883. 8°.

Ruhnke, C. Die einwirkung von alkyljodüren auf triazobenzoesäure. Inaug. diss. Göttingen, *Vandenhoeck & Ruprecht*, 1882. 36 p. 8°.

Schuver, J. M. Reisen im oberen Nilgebiet. Gotha, 1883. 95 p., map. 4°.

Siebenmann, F. Die fadenpilze Aspergillus flavus, niger und fumigatus; Eurotium repens (und Aspergillus glaucus) und ihre beziehungen zur Otomycosis Aspergillina. Medicinisch-botanische studien auf grund experimenteller untersuchungen. Mit vorwort von Dr. Alb. Burckhardt-Merian. 8°.

Smith, Adolphe. Pneumatic drainage: a description of the Berlin method. New York, *Spon*, 1883. 50 p., 6 pl. 8°.

Società crittogamologica italiana. Memorie. vol. 1. Varese, *tip. Malnati*, 1883. 10+516 p. 8°.

Staude, O. Geometrische deutung der additionstheoreme der hyperelliptischen integrale und functionen erster ordnung im system der confocalen flächen zweiten grades. Habilitationsschrift. Breslau, *Köhler*, 1883. 71 p. 8°.

Stewart, A. Nether Lochaber. Natural history, legends, and folk-lore of the West Highlands. Edinburgh, 1883. 424 p. 8°.

Streintz, H. Die physikalischen grundlagen der mechanik. Leipzig, *Teubner*, 1883. 12+142 p. 8°.

Studer, Th. Die fauna der pfahlbauten des Bieler Sees. Bern, 1883. 100 p., 5 pl. 8°.

Swinburne, J. Practical electrical units popularly explained. London, *Spon*, 1883. 62 p., illustr. 12°.

Tresca, Cours de mécanique appliquée. division 1. Paris, 1883. 327 p. 4°.

Van Tricht, V. Les enregistreurs en météorologie. Description d'un nouveau météorographe électrique. Bruxelles, 1883. 75 p. 8°.

Waechter, F. Die anwendung der elektricität für militärische zwecke. Wien, 1883. 256 p., illustr. 8°.

Wahnschaffe, M. Verzeichniss der im gebiete des Allervereins zwischen Helmstedt und Magdeburg aufgefundenen käfer. Neuhaldensleben, *Eyraud*, 1883. 5+455 p. 8°.

Wainwright, S. Scientific sophisms: a review of current theories concerning atoms, apes, and men. New York, *Funk & Wagnalls*, 1883. (Standard lib., no. 97). 302 p. 12°.

Waitz, K. Ueber den einfluss der galvanischen polarisation auf die aenderung der reibung. Habilitationsschrift. Tübingen, *Fues*, 1883. 39 p. 8°.

Walter, H., und **Dunikowski**, E. von. Das petroleumgebiet der galizischen Westkarpathen. Wien, *Manz*, 1883. 4+100 p., 2 pl., 1 map. 8°.

Ward, G. Mason. A compend of chemistry. Philadelphia, *Blakiston*, 1883. 111 p. 8°.

Wenghoffer, L. Lehrbuch der anorganischen, reinen, und technischen chemie, auf grundlage der neuesten forschungen und der fortschritte der technik, wesentlich für studirende auf universitäten und technische lehranstalten, etc. abth. 1. Stuttgart, *Wittwer*, 1883. 302 p., illustr. 8°.

Willgrod, H. Flächen, welche sich durch ihre krümmungslinien in unendliche kleine quadrate theilen lassen. Inaug. diss. Göttingen, *Vandenhoeck & Ruprecht*, 1882. 50 p. 8°.

Wilke, A. Die volkswirthschaftliche bedeutung der elektricität und das elektromonopol. (Elektrische zeitfragen, no. 1.) 8°.

Zeitschrift, internationale für die elektrische ausstellung in Wien 1883. Red.: J. Kramer und Dr. Ernst Lecher. Wochenschrift für die gesammt-interessen der internationalen elektrotechnischen ausstellung 1883. Erscheint in 24 nummern. 16. p., illustr. 4°.

Ziegler, J. M. Ein geographischer text zur geologischen karte der erde. atlas. 8°.

SCIENCE.

FRIDAY, NOVEMBER 9, 1883.

THE LICK TRUST.

It will be remembered that a certain portion of the large estate of Mr. Lick was to be devoted to the uses of science. A specific sum of seven hundred thousand dollars was to be expended in the purchase of the most powerful telescope attainable, and in the construction of an observatory on Mount Hamilton; and the unexpended balance of this sum was to constitute a permanent fund for the maintenance of the observatory. Many specific bequests were made for other purposes not scientific; and after all these specific sums had been paid, it was provided that the sum remaining over should be divided between the Society of pioneers of California and the California academy of sciences. Science is interested, also, in this last bequest. It will be remembered that many changes of trustees, and also of the form of the gift, were made in the early years of the trust; and that vexatious suits were entered by supposed heirs of Mr. Lick, which were successively decided by the courts. At present a definite construction of the deed of trust has been made by the supreme court of California, from which there is naturally no appeal; and the trustees are acting under this construction.

During the period of years over which the preliminary litigation extended, a great shrinkage in the values of real estate took place in California, as well as elsewhere in the United States. At the end of these litigations, the trustees found themselves in control of much valuable property, which could be sold only at a great loss. If it had been sold at that time, there would have been no money left to divide between the pioneers and the academy; and not only this, but some of the specific bequests would have remained unfulfilled: it was therefore the policy of the trustees to manage the estate carefully, and to sell only to advantage. In this way only, would the residuary legatees receive any considerable sum. The estate has certainly been well managed: for from Dec. 1, 1876, to Oct. 1, 1883, the aggregate net profits have been $453,458, or over $66,000 per year. There was no surplus to divide in 1876; while, at the present time, some $192,000 remains over, free of all specific bequests. It therefore would appear that the trustees have deserved well of science for their careful administration of the trust.

Their policy has clearly been wise, when looked at without prejudice: but it has not been acceptable to the residuary legatees, since they have not yet received any immediate benefit; nor can they, under the decision of the court, until the whole estate is settled, and all specific bequests are fulfilled.

This is no doubt annoying to the academy of sciences, which has so many useful purposes which could be served by an increased income. It is specially annoying to the pioneers, who all came to California in 1849–50, and who, therefore, are all men in middle life. When the French countess heard of the Montgolfiers' balloon ascension, she exclaimed that these men would certainly invent the art of never dying; but she added pensively, 'It will be when I am dead.' This is the very natural attitude of the pioneers; and it is this that has led to a recent savage attack on the trustees, reports of which have appeared in the San Francisco and other papers. These attacks have been directed against the whole action of the trustees, without discrimination. It is, however, clear, that the actions of the trustees must be considered in two ways. Most of their official acts have been done under specific directions of the courts of law. These acts are much complained of by the residuary legatees: but it is obvious that such complaints are idle; for, if the trustees had not obeyed the orders of the courts, they would have been long since expelled from their responsible positions. The remaining acts complained of have been done in pursuance of the general policy just outlined. It seems equally clear that these complaints, though natural, are unjust. The residuary legatees have now $192,000 to divide. It is not long since they had nothing. Science is certainly grateful to the trustees, since their economical policy has already saved a large sum which will eventually go to making the California academy of sciences more powerful and useful than it now is.

With regard to the other beqnest in which science is interested, — namely, the Lick observatory, — there is every reason to be extremely grateful to the trustees for their wise administration of the trust.

Their economy has certainly been remarkable. They have expended on the observatory to Oct. 1, 1883, $154,527.98; and they have remaining $545,472.02. This $155,000 has done the following things:. the top of a bleak mountain four thousand feet above the sea, and twenty-seven miles from a town, has been levelled off so as to give a sufficient area for the buildings (forty thousand tons of rock have been removed for this purpose alone); brick enough to complete the whole of the buildings has been made on the side of the mountain, and delivered at the top, at a total cost less than the price of hauling the same amount from the nearest town; a handsome and well-built main building is now nearly finished (the large dome alone remains; a small dome, containing a very perfect twelve-inch equatorial by Clark, has been in use since November, 1881); a four-inch transit instrument, in a convenient house, is in complete working-order; a photoheliograph in a permanent house has been in use since December, 1882; the house for the meridian circle is begun; the meridian circle is half paid for, and a payment has been made on the large telescope. This is the work which is to be seen on the mountain-top proper. Just below this are the houses for the workmen, shops, stables, etc., all in good condition, and a very complete system of water-supply in full working-order.

It will appear to any competent person that this work has been done thoroughly, and that it has been done economically. At the same rate of expenditure, at least $300,000 will remain as a permanent fund for the support of the observatory.

It therefore appears that the trustees have deserved well of science in their administration of their trust, not only in regard to the California academy of sciences, but also in relation to the Lick observatory; and it should be the desire of all interested in the administration of this trust to strengthen the hands of the trustees in the continuance of their wise policy.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — II.

The further growth of the desert-whirl may be briefly described. The air standing quietly on a flat, dry surface allows the lower strata to be quickly warmed to a high temperature. If the air were in motion, no part of it would remain long enough close to the ground to be greatly warmed; if the surface were not flat, the lower air would flow up the slopes as soon as it was a little heated, and not wait to acquire a high temperature; if the surface were wet, much of the sun's heat would be occupied in evaporating the water (as will be explained below), and would so be lost to the lower air: it is therefore only in calm weather, on a desert plain, that the sun can succeed in warming the lower air to excess, and so produce a very unstable equilibrium, and a strong updraught when the upsetting begins. The longer the delay before the overturning, the more heat-energy is accumulated, and the more violent the motion when it begins. The lower air rises at some point against the oppression of the upper layers. The surrounding warm air flows in from all sides toward this central point, and follows the leader. Soon the motion becomes general and lively, dust and sand are blown along toward the centre, lifted and carried aloft with the ascending air in its rapidly rising current, and then the whirling column becomes visible. When thus established, the increased velocity and the rotary motion of the air near the centre are constant characteristics of the upsetting. Thirty

[1] Continued from No. 39.

or forty feet to one side, the wind may not be strong enough to brush along the sand, and a few hundred feet away it may not be perceptible; but at the centre it makes a distinct rushing or roaring sound, and carries light objects upwards, sometimes to a height of several thousand feet. This increase of velocity of the surface indraught toward the point of its upward escape is a general feature of the motion of a mass of free particles along a path of varying width: the narrower the path, the faster the motion. The same increase is seen in the growing velocity of a stream running out of a lake, so beautifully shown where the Rhone those of the tornado, as will be shown farther on.

The second characteristic feature of the wind's motion gives name to the storm. A whirl must necessarily be formed when the air moves inwards from all sides towards a centre, for the indraughts will surely fail to follow precisely radial lines. Their aim will be a little inexact; and, as they pass to one side or the other of the centre, a turning must begin in a direction determined by the strongest current. This, once begun, is maintained by the centrifugal force that arises from it; and the size of the central whirl will then depend on the bal-

Fig. 3. (Taken from *Amer. journ. sc.*, 1851.)

flows from Lake Geneva, or, more simply and prosaically, in the running of water from a tub by the escape-pipe. In the case of a desert-whirl, the central wind is held by friction with the surface sands much below the velocity it might attain; for it must be remembered that these whirls are supplied by a comparatively thin layer of superheated air next to the ground, often not more than four or five feet thick. The restraint of friction on such a layer will be very considerable, and its motion can seldom reach a disastrous strength. It is probable that in the desert sand-storms, which are described as overwhelming caravans, there is a much thicker mass of air in activity, and the conditions of motion approach ance between the centripetal and centrifugal forces. In ascending at the centre, the wind follows an upward spiral course, like the thread of a screw of steep pitch, with a diameter of five to twenty feet. The direction of turning is indifferently one way or the other, according to the side on which the indraught happens to pass the centre. The height to which the whirling column rises will be determined by its mixture with the adjoining air, and consequent cooling until its temperature is that of indifferent equilibrium; and at this elevation the current will turn and spread laterally to make room for that which follows. Such a whirl will continue as long as its cause lasts; that is, as long as it is supplied with warm air at the base.

Manifestly it must stop in the afternoon, as the sun's heat decreases; and it can never occur at night, for then the surface-air is, as a rule, cooler than that above, and the atmospheric equilibrium is correspondingly stable. Further, the whirl will remain at one place, unless, as is often the case, it is carried along by a general motion of the upper air.

There is a very strong point of evidence, if any is needed, in favor of the view that heat applied to the lower layers of the air will produce a whirlwind. This is the fact of their pro-

FIG. 4. (Taken from *Abhandl. gesellsch. wiss. Gött.*)

duction over fires. Much interest was excited in this question in connection with the artificial causing of rain, some forty years ago, in this country; and observations were carefully made of the whirls formed over burning woods and canebrakes, showing them to be very similar in form and action to those naturally arising on dry plains (fig. 3). Similar whirls have been seen over volcanoes (fig. 4); and on a calm day the smoke ascending from a factory chimney may be seen to have a slow rotary motion. Heat is therefore an amply sufficient cause of such disturbances. No other excitement is needed, and electricity has no essential part to play. In recognizing this, we see the chief difference between the older and newer theories of storms.

Sand-whirls are common in all desert or dry regions, where they often have the name of spirits or devils, from the fantastic and apparently evil way in which they flit across the burning sands. They have neither clouds nor rain. When well and frequently developed, they may grow to dangerous strength, and lift much dust and sand into the upper air, where it is blown long distances before falling. In this way they serve as important geologic agents. Vessels west of the Sahara, or east of China, are thus often powdered over with fine dust slowly settling down after a long flight from its desert source.

The smaller water-spouts, doubtless, belong near here in our scheme of classification; but as they are usually aided by vapor-force, and approach the character of tornadoes, their consideration is best deferred till later.

Finally, before going on to the larger storms, one point of much importance must be emphasized. The change from the stable equilibrium of night and early morning to the unstable of noon is effected entirely by the sun's heat, which warms the lower air, and causes it to expand. In expanding, it lifts all the upper air that rests on it; and this is no small piece of work, for the air that is lifted weighs about a ton over every square foot. When a point of escape is found, the heavy upper air sinks again, as the expanded air is drained off (upwards) at the centre. It is this gravitative force of the sinking air-mass that causes the dust-whirlwind, in re-arranging the disturbed equilibrium of the atmosphere; but gravity would have no chance to show its strength, if the air had not been lifted by force from the sun. The winds of a dust-storm, therefore, depend on gravitative force brought into play by the sun's heat. All storms and all winds have more or less closely this relation to solar energy and terrestrial gravity.

(To be continued.)

THE INTERNATIONAL FISHERIES EXHIBITION.—FOURTH PAPER.

ON the 1st of October, at noon, the number of visitors to the exhibition passed the much desired limit of two millions; and, although the rainy season had set in, the daily average of attendance was still increasing. The financial success of the enterprise was more than certain two months ago; and the receipts of each day since have been swelling the surplus fund, the disposal of which is now a fruitful subject of discussion in England. Although the organization is a private one, the character of the men in control of it, and the recognition granted by the Queen and the Prince of Wales, render it certain that the profits will be devoted to some public enterprise. In the midst of multifarious minor propositions, two plans are receiving serious support. One of these is that first brought forward by Professor Ray Lankester, in his address upon 'The (possible) scientific results of the exhibition,' and relates to the establishment of a laboratory of marine zoölogy in Great Britain, for the joint advantage of fisheries and science. Professor Lankester's original memorial was signed by sixteen leading men of science, and has since had the indorsement of the British association. The rival scheme relates to the establishment of an orphanage for fishermen's children; and this, as may be imagined, is much more popular among the people and their newspaper exponents. One influential trade-journal expresses itself in energetic fashion in a paragraph which I cannot refrain from quoting, since it shows how little the opinion of a large class of Englishmen has been acted upon by the leaven of scientific thought. Speaking of the meeting of the British association, the editorial proceeds: —

"The conductors of the daily prints, always very amiable to the promoters of these useless gatherings, fool the *savants* to the top of their bent by reporting the 'papers' and discussions at an absurd length, thus making the credulous 'scientists' believe that the public takes a lively interest in their proceedings. . . . It is [the president's] grim task to write an 'address' usually so wildly mystifying as to drive his hearers and readers to the verge of idiocy. By common consent, this year's presidential address was not only more bewildering than any previously delivered, but absolutely incomprehensible; and it is charitably hoped that the Southport meeting is the beginning of the end. But these dreamy gentlemen are sufficiently wide awake to their own interests. . . . This they are, of course, entitled to do; and, if they can squeeze any money out of the public or out of the government, to aid them in the pursuit of their 'fads,' we shall have nothing to say. When, however, they go to the length of proposing to get a portion of the fisheries exhibition surplus into their hands for the purpose of establishing 'a marine zoölogical station on the English coast,' we take leave to denounce such a proceeding as both audacious and preposterous," etc.

In the mean time the executive committee makes no promises, except in the proposition to expend the sum necessary to bring over a Cape-Ann schooner, with a selected crew of fishermen, to demonstrate the American methods of fishing with purse seine, deep-sea trawl-lines, and dories, on those parts of the British coasts in which their use may be practicable. If any precedent is required for devoting a part of the proceeds to scientific ends, they have only to look to the Edinburgh exhibition of 1882, the surplus of which to the amount of nearly eight thousand dollars has been given to establish a marine laboratory near Edinburgh, under the direction of Mr. John Murray of the Challenger, and others. It is to be hoped that the demands of science will be remembered. Charities of all descriptions flourish luxuriantly in England, but the workers in science seem to feel that their needs are often seriously neglected.

The amount of the surplus is variously estimated at from forty thousand to a hundred and fifty thousand dollars. The management is not satisfied with the present success, however, and has leased the grounds for three years more from the commissioners of the exhibition of 1851, who, it will be remembered, bought with the surplus of that great enterprise those tracts of land now so valuable, on which all the museums and schools of science and art in South Kensington are now placed. Three great international exhibitions, similar in plan to the fisheries exhibition, are to follow, year by year; and by the end of 1886 the buildings will have more than paid for themselves, and a substantial sum will have accumulated, to be used, perhaps, in continuing the exhibition and museum movement which England has found to be so valuable to its intellectual and industrial welfare. The character of these exhibitions has not yet been determined upon. That of 1884 would doubtless have been devoted to horticulture, floriculture, and forestry, had not Scotland pre-occupied the field with a similar undertaking, and already secured the patronage of royalty. Edinburgh will therefore have its 'international exhibition of objects relating to practical and scientific forestry and forest products' next year; and London will follow in 1885 with a forestry exhibition, which cannot fail to be of world-wide importance. The London fisheries exhibition of 1883 gained much through the experiences of similar exhibitions in Norwich in 1881, and Edinburgh in 1882. The subject of the London exhibition of 1884 is not announced, but it is very possible that it will have to do with food-products. Another programme, hinted at by the Prince of Wales in his speech at the close of the exhibition, provides for a hygienic exhibition in 1884, one of the progress of invention in 1885, and in 1886 an exhibition of colonial products.

The literature of the exhibition is one of its most important features. Almost every subject connected with marine zoölogy and the technology of fishing has been discussed in at

AMERICAN SECTION OF THE INTERNATIONAL FISHERIES EXHIBITION IN LONDON.

least one special essay. The papers published by several foreign governments have been of great importance, particularly the treatises by Grimm, upon the fishes and fisheries of Russia, and by Apostolides, upon those of Greece. Those issued officially by the exhibition have been numerous, and, if the truth must be told, by no means of equal merit. None, however, are without value; and several, especially those by Huxley, Levi, Hubrecht, Lankester, and Day, are important contributions to science.

The official catalogue, edited by Mr. A. J. R. Trendell of the South Kensington museum, well known in America as the secretary of the British commission to our exhibition in 1876 at Philadelphia, is in itself a contribution to knowledge, and a model for the guidance of future exhibition administrations. Each section is introduced by an essay by some recognized authority, and signed. Much serious work has been done by the English periodicals in recording the teachings of the exhibition. *Nature*, under the head of 'Zoölogy at the fisheries exhibition,' has had a review of the vertebrates by Professor Giglioli, and of the invertebrates by Professor Ray Lankester; also a paper on the present state of fish-culture as illustrated at the exhibition, by Mr. Earll. The birds have been considered by Mr. Howard Saunders in the *Ibis*, and by Mr. J. E. Harting in the *Zoölogist*. Mr. Gwynn Jeffreys described the molluscan collections in the *Annals and magazine of natural history*. Mr. Dunell, Mr. W. B. Tegetmeier, Mr. Senior, and others have reviewed the technological features in the *Field*, and Mr. Fell Woods, the oyster-collections in *Land and water;* while *Engineering* has had an elaborate series of illustrated papers upon the vessels and scientific instruments, devoting several numbers to describing the U. S. steamer Albatross and its equipment, and to American devices for the exploration of the depths of the sea.

An official review, elaborately illustrated, of the exhibition and its teachings, is being prepared for the British government by Hon. Spencer Walpole, governor of the Isle of Man, well known as the colleague of Huxley and Buckland in the various fishery commissions from time to time instituted by Parliament.

Nearly every European government has sent hither specialists to report upon special subjects. Among the most eminent of these men of science have been Dr. Steindachner of Vienna, Dr. Sauvage of Paris, Dr. Möbius of Kiel, Professor Benecke of Königsberg, Professor Hubrecht and Dr. Van Beinmelen of Utrecht, Professor Giglioli of Florence, Dr. von Grimm of St. Petersburg, Dr. Malmgren of Finland, Professor Torell of Stockholm, Dr. Buch of Christiania, Mr. E. P. Ramsay of Sydney, Capt. Comerma of the Spanish navy, and Col. Sola of Madrid. The reports yet to be published will perhaps swell the literature of the exhibition to double its present bulk, and will be of interest to investigators in every department.

The exhibition was formally closed on the 31st of October by the Prince of Wales, who in his speech upon this occasion made certain very fitting allusions to the work of his father, Prince Albert, in the promotion of international exhibitions. G. BROWN GOODE.

A FOUR-DAYS' CRUISE OF THE ALBATROSS.[1]

WE left Wood's Holl at 4.10 P.M., Sept. 29, for an offshore dredging-trip. The weather was clear and pleasant, with light southerly winds and smooth sea.

At 9.02 A.M. the following day, we sounded in 1,342 fathoms, — bottom, globigerina ooze; latitude 39° 29′ north, longitude 70° 58′ 40″ west, — and at 9.38 put over the beam-trawl, veering to 1,900 fathoms of rope. It was up again at 1.03 P.M., the net containing a large number of specimens. [Station 2,095.]

The trawl was cast again at 2.44 P.M., in 1,451 fathoms, latitude 39° 22′ 20″ north, longitude 70° 52′ 20″ west. The bottom specimen brought up in the Sigsbee cup was the same as that of the former cast: but the trawl contained a granite stone weighing a hundred and seventy pounds, several small stones, small pieces of cinder, and lumps of hard clay; there were also several small specimens of what appeared to be oxidized iron. The haul was very successful, being particularly rich in foraminifera. [Station 2,096.]

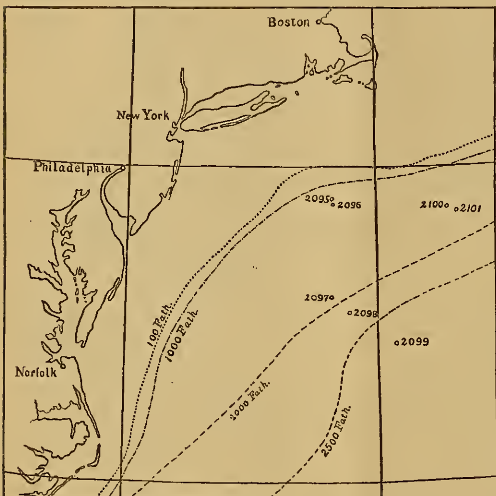
As soon as the trawl was up, a set of serial temperatures and specific gravities was taken to 1,000 fathoms. A temperature of 66° was found at 25 fathoms, 65½° at 60 fathoms, and 57½° at 40 fathoms. These strata of cold and warm water are the rule rather than the exception, in this locality; but, thinking that possibly the observation at 40 fathoms had been read incorrectly, it was verified, using another instrument, which registered 55½°.

At 8.22 P.M. we started ahead south ¾ west

[1] Report to Prof. S. F. BAIRD, U. S. commissioner of fish and fisheries, by Lieut.-Commander Z. L. TANNER, U. S. N., commanding U. S. fish-commission steamer, Albatross, kindly placed at our service by Professor Baird. Some of the appendices are abbreviated to save repetition.

(magnetic), running on that course till 5.30 A.M., Oct. 1, when we sounded in 1,917 fathoms, — latitude 37° 56′ 20″ north, longitude 70° 57′ 30″ west; bottom, globigerina ooze, — and at 6.18 put the beam-trawl over, veering to 2,600 fathoms. It was on the bottom at 8.04; and at 9.04 we began heaving in, landing it on the deck at 10.42 A.M., having made a successful haul. [Station 2,097.]

At 2.08 P.M. the beam-trawl was lowered again in 2,221 fathoms, latitude 37° 40′ 30″ north, longitude 70° 37′ 30″ west. It was down, with 3,000 fathoms of rope out, at 4.03



P.M., dragged till 5.14 P.M., and was landed, after a successful haul, at 7.24 P.M. [Station 2,098.]

At 7.34 P.M. started ahead south-south-east (magnetic), ran till 3.26 A.M., and lay to until daylight (about 5.30 A.M.), when we sounded in 2,949 fathoms, — bottom, globigerina ooze; latitude 37° 12′ 20″ north, longitude 69° 39′ west, — near the centre of the Gulf Stream. The sinker, sixty-four pounds weight, was thirty-four minutes in reaching the bottom; and the specimen-cup came up in thirty-six minutes. The thermometer registered at some intermediate depth not far from the surface, having capsized in some way in its descent. [Station 2,099.] The net of the beam-trawl was examined with great care, and every foreign substance removed, so that there should be no doubt as to whether specimens found were taken during the haul, or were in the net when it went down.

At 7.14 A.M. the trawl was put over, reaching the bottom at 10.13½, having veered 4,100 fathoms of rope. At 0.54 P.M. began heaving up, and at 3.18 P.M. it was landed on deck. It was a successful haul in every respect.

The moderate breeze of the morning increased to a strong wind with heavy swell before the trawl was up, making it doubtful whether we should succeed in landing it. A set of serial temperatures and specific gravities was attempted after finishing the haul; but the strong current, high wind, rugged sea, and threatening weather forced us to give it up after having veered 300 fathoms of rope. The method adopted to regulate the drift was at least original. The current of the stream was so strong that the trawl would not take the bottom; and, to effect this object, an officer was stationed on the forecastle with a dredging quadrant, constantly observing the angle of the dredge-rope, the engines being moved with sufficient speed to maintain it within certain prescribed limits.

At 4.30 P.M., moderate gale from south-west; hove to under fore storm-staysail, head to the southward, drifting rapidly with the stream about north-east by east. At midnight it was blowing a moderate gale with heavy sea, barometer 29.76, the air exceedingly sultry, and incessant flashes of lightning in every direction. At 1.40 A.M., 3d inst., started ahead, course north, and ran under moderate speed till 11.05 A.M., when, wind and sea having moderated, we sounded in 1,628 fathoms, globigerina ooze, — latitude 39° 22′ north, longitude 68° 34′ 30″ west, — and at 12.13 P.M. put the beam-trawl over, veering to 2,300 fathoms. There was still a fresh breeze from north-west, with heavy swell and very strong stream. The trawl was down at 1.59, dragged till 3.08, and was landed at 4.25 P.M. There were some interesting specimens, but most of the things were washed out of the net on the way up. [Station 2,100.]

At 4.31 P.M. we sounded in 1,686 fathoms, globigerina ooze, — latitude 39° 18′ 30″ north, longitude 68° 24′ west, — and at 5.15 P.M. put the trawl over, veering to 2,650 fathoms. It was on the bottom at 7.10, began heaving up at 8.15, and landed it on deck at 9.39 P.M. The heavy swell and strong stream combined washed a large proportion of the specimens from the net, but several new or rare species were secured. [Station 2,101.]

A course was laid to the northward as soon as the haul was finished, and the speed registered so as to strike the 100-fathom line in longitude 67° 50′ west, at daylight, when we proposed setting a trawl-line for tile-fish. We were on the ground at the proper time; but the weather was so boisterous that it was not considered prudent to lower a boat. It was too rough even for dredging; and, as our coal-supply was nearly exhausted, we started for port.

We encountered strong head-winds during the day, finally anchoring in Tarpaulin Cove at 10.40 P.M., where we remained till 6 A.M. on the 5th, when we got underway, and arrived at Wood's Holl at 6.40, making fast to our moorings.

List of fishes obtained.

BY ENSIGN R. H. MINER, U.S.N.

Station 2,095. — Bathysaurus Agassizii, Stomias ferox, Macrurus asper, Coryphaenoides carapinus, Halosaurus macrochir, Haloporphyrus viola, Cyclothone lusca, and one new species.

Station 2,096. — Eurypharynx, Haloporphyrus viola, Macrurus asper, Synaphobranchus pinnatus, Halosaurus macrochir, Coryphaenoides carapinus.

Station 2,097. — Berycid (new species), Macrurus asper, Cyclothone lusca, Scopelus.

Station 2,098. — Macrurus asper.

Station 2,099. — Cyclothone lusca, Scopelus, Berycid (new species), two new species.

Station 2,100. — Cyclothone lusca, Scopelus, Forcipichthys.

Station 2,101. — Berycid (new species), Eurypharynx, Cyclothone lusca, Argyropelecus Olfersii, Sternoptyx diaphana, Scopelus, two new species.

Register of invertebrates captured.

BY J. E. BENEDICT.

The results obtained were good, notwithstanding the sea was quite rough much of the time. The surface-nets were in use when practicable, and a number of fine specimens were taken in them. As heretofore, schools of squid were seen in the water, illuminated by the arc-light. One of the crew captured

Dredging and trawling record.

Date.	Station.	Locality. Latitude, north.	Locality. Longitude, west.	Locality. Hour.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth in fathoms.	Kind of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Distance.	Trawl used.
1883.														
Sept 30. .	2,095	39° 29′ 00″	70° 58′ 40″	9.02 A.M.	71½	69½	..	1,342	Glob. oz.	S.S.W. .	3	S. . .	2′.0	Beam.
" 30. .	2,096	39 22 20	70 52 20	2.07 P.M.	70	69	37½	1,451	" "	" .	2	S.W. .	1 .5	"
Oct. 1. .	2,097	37 56 20	70 57 30	5.30 A.M.	73	72½	..	1,917	" "	S.W.. .	3	S ½W..	1 .5	"
" 1. .	2,098	37 40 30	70 37 30	1.08 P.M.	73	72½	..	2,221	" "	N.W.. .	4	W.×S.,	2 .0	"
" 2. .	2,099	37 12 20	69 39 00	5.30 A.M.	71	82	..	2,949	" "	S.E. . .	6	S.S.W.	2 .0	"
" 3. .	2,100	39 22 00	68 34 30	11.05 A.M.	63	69	37½	1,628	" "	W.N.W.,	3	E. . .	2 .0	"
" 3. .	2,101	39 18 30	68 24 00	4.31 P.M.	61	67	37	1,686	" "	W.S.W..	3	S. . .	2 .0	"

Meteorological record.

Date.	Barometer. Maximum.	Barometer. Minimum.	Air. Maximum.	Air. Minimum.	Wet bulb. Maximum.	Wet bulb. Minimum.	Surf'ce water. Maximum.	Surf'ce water. Minimum.	State of weather.	Wind. Direction.	Wind. Force.	State of sea.
1883.												
Sept. 29. .	30.32	30.18	71	56	69	56	64	57	Passing clouds	E., N.W., S.	1–3	Smooth.
" 30. .	30.18	29.92	72	64	72	64	70	60	" "	S., S.S.W. . . .	2–4	"
Oct. 1. .	30.06	29.86	80	66	78	65	75	71	" "	S.S.W., N.W., N.E. .	2–4	Moderate.
" 2. .	30.10	29.76	82	67	81	65	83	76	" " squally . . .	N.E., S.E., S.W. . .	2–8	Rough.
" 3. .	30.12	29.76	78	61	77	57	82	67	" " " . . .	N.N.W., W.N.W. .	3–7	"
" 4. .	30.36	30.12	64	45	62	43	66	55	Clear and pleasant	N.N.W., W.N.W. .	4–7	Rough, then moderate.

three of them with the squid-jig. Several land birds were seen far out at sea. A pair of kingfishers (Ceryle alcyon) flew about near station 2,096. A pair of fish-hawks (Pandion haliaetus) acted as if they were at home near station 2,099, 250 miles from land. A golden-winged woodpecker (Colaptes auratus) and a song-sparrow (Melospiza melodia) came on board to rest, at station 2,100.

The principal invertebrates taken were as follows:—

Station 2,095. — The sounding-cup brought up ooze containing foraminifera from a depth of 1,342 fathoms. The beam-trawl was put over with wings attached. Among its invertebrates were twenty-five holothurians (Benthodites), many large zoroasters, several cup-corals (Flabellum), a shrimp nine inches long with very large eggs, three specimens of a crab (? Galacantha). Some of the holothurians were placed in picric acid before putting them into weak alcohol. A portion of the eggs were taken from the large shrimp, and preserved in Müller's fluid for the study of the embryos, which were plainly visible within.

Station 2,096.— Again the sounding-cup brought up ooze with foraminifera, this time from a depth of 1,451 fathoms. Strange to say, a large stone, weighing upward of a hundred and seventy pounds, was brought up with sponges and worm-tubes attached. This would, I think, preclude the possibility of its being below the surface of the foraminiferous ooze, which came up in quantity sufficient to yield two quarts of clean foraminifera. The principal ingredients found in the stone were quartz, hornblende, and iron. Eighteen holothurians (Benthodites), many specimens of a small ophiuran, a few large shrimp, and some small shells, made up the bulk of the material.

Station 2,097. — Bottom, ooze, with foraminifera from a depth of 1,917 fathoms. One amphipod three inches and a half long, shrimp, Epizoanthus on hermit-crabs (species unknown), Urticina concors Verr. on Sympagurus pictus Smith, Ophioglypha convexa Lym. and Ophiomusium armigerum Lym. in small numbers, a starfish remarkable for its large madreporic plate and ambulacral feet, small ascidians coated with foraminifera.

Station 2,098.— Depth, 2,221 fathoms. Epizoanthus, Urticina concors Verr on Sympagurus pictus Smith, Ophioglypha convexa Lym. and Ophiomusium armigerum Lym., also a few shells.

Station 2,099. — This haul was remarkable from the fact that the sounding was in water 2,949 fathoms. This is perhaps the deepest water ever successfully invaded by a large trawl: certainly it is the deepest we have record of with any trawl. The trawl went down more than three miles at the end of upwards of four miles and a half of wire rope without capsizing, and that in the middle of the Gulf Stream, while the water was quite rough. That there might be no question as to the specimens brought up, the captain had the net thoroughly cleaned before it was put over the side. The amount of material brought up was not large. The only specimens from the bottom were a species of Boltenia, and many fragments of a Bryozoon we had not seen before. A fine large schizopod, with several species of shrimp and small crustacea, were taken in good condition. These, with a cephalopod and the fish, made it one of the best hauls.

Station 2,100, with a depth of 1,628 fathoms, and 2,101 with a depth of 1,686 fathoms, brought us only shrimp and fish.

Specific gravities of sea-water.

BY P. A. SURGEON, C. G. HERNDON, U.S.N.

Date.	Station.	Depth.	Temperature air.	Temperature by attached thermometer.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Reduced to 60°.
12 M.							
Sept. 30 .	2,095	Surface.	71°	69°	71°	1.0251	1.026706
" 30 .	2,095	5	71	67	71	1.0251	1.026706
6 P.M.							
Sept. 30 .	2,096	Surface.	70	70	72	1.0251	1 026864
" .	2,096	5	70	67 .5	72	1.0251	1.026864
" .	2,096	10	70	68	72	1.0251	1 026864
" .	2,096	15	70	68	72	1.0252	1.026964
" .	2,096	20	70	67	71	1.0253	1.026906
" .	2,096	25	70	66	67	1.0257	1.026687
" .	2,096	40	70	57 .5	67	1.0264	1.027387
" .	2,096	60	70	55 .5	67	1.0266	1.027587
" .	2,096	100	70	55 .5	84	1.0236	1 027512
" .	2,096	200	70	47	85	1.0235	1.027600
7 P.M.							
Sept. 30 .	2,096	300	70	40 .5	85	1.0235	1.027600
" .	2,096	400	70	40	85	1.0235	1.027600
" .	2,096	500	70	40	85	1.0235	1.027600
" .	2,096	600	70	39 .5	86	1.0233	1.027616
" .	2,096	700	70	39 .5	85	1.0235	1.027600
" .	2,096	800	70	38 .5	85	1.0238	1.027700
" .	2,096	900	70	39	86	1.0235	1.027816
8 P.M.							
Sept. 30 .	2,096	1,000	70	38 .5	86	1.0235	1.027816
6 P.M.							
Oct. 1 .	2,097	Surface.	66	69	75	1.0253	1 027565
" .	2,097	5	66	68	75	1.0253	1.027565
2 P.M.							
Oct. 2 .	2,098	Surface.	79	74	76	1.0248	1.027232
" .	2,098	5	79	72	76	1.0248	1.027232
7 P.M.							
Oct. 3 .	2,101	Surface.	63	68	75	1.0246	1.026865
" .	2,101	5	63	69	73	1.0248	1.026724

THE ZOÖLOGICAL STATION OF HOLLAND.[1]

For some years past, zoölogical science has been pursuing a course abounding in brilliant discoveries. The examination, however minute, of animals preserved in collections, no longer satisfies the naturalist: he must study the living animal. Zoölogy has become experimental. On all sides, maritime stations are being established. Numerous works on anatomy and embryology have cleared up the philosophical theory of the transformation of animals by showing that the metamorphoses, which, less than half a century ago, were almost unknown, are very common among marine animals.

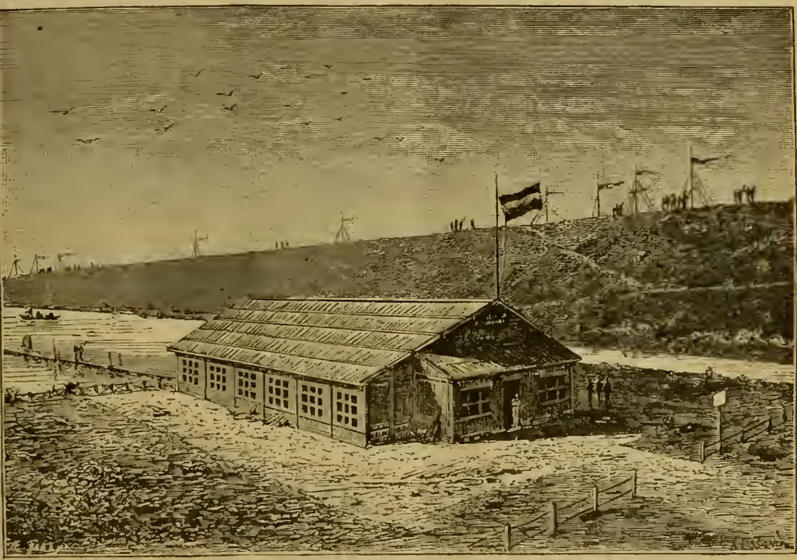
Holland, which has produced so many great anatomists and such patient naturalists, seemed to be tardy in following the example of neighboring nations, when, on the 4th of December, 1875, at the instiga-

[1] Translated from *La Nature* of Sept. 8.

tion of Professor Hoffman, its president, the Zoölogical society of the Netherlands voted to erect a zoölogical station on the shore of the North Sea. A committee, composed of Messrs. Hoffman, Hubrecht, and Hoek, decided on the erection of a station which could be easily transferred from one point to another on the Netherland coast. With its sandy shores and gradual slope, Holland has, it is true, a comparatively poor zoölogical fauna. The committee thought, therefore, and rightly, that a movable station would be more serviceable, as it would permit successive exploration of various parts of the shore.

The appeal made by the Netherland society to the generosity of the state, to scientific societies and private individuals, met with a response; and the sum of ten thousand francs was soon obtained. Work was immediately begun. The choice for the first season fell upon the city of Helder, situated at the northern extremity of the province of North Holland, at a point where an arm of the sea, called Helsdeur, separates the mainland and the island of Texel. The material, loaded in a wagon drawn by cattle, reached its destination, July 8, 1876. Three days after, the station was in readiness, and studies were begun.

As throughout the coasts of the Netherlands, the bottom of the sea is, at Helder, chiefly composed of shifting sand; and one can scarcely, under such circumstances, expect to meet with those fixed animal forms which constitute the wealth of rocky bottoms. Few species can resist the sand which covers and smothers them. But while the downs extend west of the city of Helder, at the north there rises a spur of granite and basalt, in the irregularities of which numerous animals find shelter: it is the only point on the coasts of Holland where seaweeds are found. The minister of the marine having consented to place twice a week a steam-launch at the disposal of the commission, the little dredges invented by Wyville Thompson and the apparatus of Lacaze-Duthiers were employed, and a hundred and thirty species obtained.



THE DUTCH ZOÖLOGICAL STATION.

The second year the station was established at Flessingue; and the coast of Zealand proved not less rich in animal forms than the slope of Nieuvediep and the bank of Helder. In the years following, the station was at Bergen-op-Zoom.

During these latter seasons, the commission has not wholly devoted itself to the examination of animals which live on the coasts of Holland. Researches at the station have since aimed to furnish oyster-cultivators with information as complete as possible, on the anatomy, the embryology, the enemies, and diseases, in a word, on the biology, of the oyster. The eastern Scheldt has to-day become an important centre for oyster-culture; so much so, that the two stations, Kruiningen in Zealand, and Bergen-op-

Zoom in North Brabant, exported in 1881 about two million oysters, valued at some three million francs.

In order that the building may be easily taken to pieces and put in position, it is made entirely of wood; and the parts are arranged with such care that its removal from one place to another requires only three days besides the transit.

The station was at Bergen-op-Zoom when we visited it, and we were received by Professor Hubrecht with the cordiality and kindness characteristic of the *savants* of Holland. It is composed of a principal building about eight metres long and five broad. One façade has four windows; the other, three. The walls are three metres high; the ridge of the roof, four and a half. The framing of the roof is of wood, covered with a double layer of rush-matting. Opposite each window there is a stationary table: tables are also arranged in the centre of the room. In the laboratory are a closet for the instruments, another for the reagents and bottles, and also a small library, containing periodicals and the principal works on marine faunas. Each investigator can, in addition, send for books which he needs, either from the library of the zoölogical society, or from one of the universities of Holland. A desk, foot-rests, and some folding iron chairs complete the furnishings. The work-room, properly so called, is entered through a room in which are the aquaria, the collecting-apparatus, and the smaller dredges. The cumbersome instruments are placed in a room connected with one of the side-façades. Another room, opposite the entrance, leads into the private office of the director of the station. A fence of galvanized zinc wire runs around the building, and, while it wards off the thoughtless, encloses a space which may be used either for experiments in the open air, or for the dissection of animals of large size.

The construction of the house, as it stands to-day, has cost fifty-five hundred francs. An additional sum of six thousand francs was expended in the purchase of furnishings, aquaria, collecting-apparatus, reagents, thermometers, lenses, etc.

The management of the station is regulated in a very simple manner. The members of the zoölogical society nominate each year a committee, which publishes at the end of the year a report of the work, and gives an account of the funds expended.

Although the resources of the zoölogical commission are very limited, nevertheless the members have undertaken important work. During the season at Helder, Mr. Hubrecht was engaged upon fishes; Mr. Hoek studied the crustaceans; Mr. Horst, annelids; while Messrs. Van Harem, Noman, and Sluiter studied the other invertebrates. Mr. Hoek undertook, at Bergen-op-Zoom, his interesting researches on the embryology of the edible oyster. H. E. Sauvage.

LETTERS TO THE EDITOR.

The formation of tornadoes.

In the discussion of Mr. Hoy's paper before the American association for the advancement of science, at the recent meeting at Minneapolis, I notice a number of statements which seem to me erroneous. Professor Rowland, for instance, asserts that "the rotation of the tornado is a necessary consequence of the earth's rotation." Now, if this be true, why are not tornadoes more frequent? Why is it necessary to have brisk, southerly winds, with high temperature and low barometric pressure? Why do they not happen on clear days as well as on cloudy ones? Again: if the earth's rotation determines the direction of the gyratory motion of tornadoes, why does it not govern the motion of the little whirlwinds occurring in dry weather? Every observer knows that these revolve, sometimes in one direction, and sometimes in the other, but perhaps, in a majority of cases, in the same direction as tornadoes.

It is well known that tornadoes in our latitude occur on days when there is a strong breeze from a southerly direction. Now, the air on such days, in spring and early summer, is heavily charged with moisture; to which fact is due the oppressiveness of the heat. As the heat of the day increases, local showers are formed, which move, not with the surface-wind, but in a higher current from a westerly direction. There is usually a divergence of about ninety degrees in the angle formed by a line indicating the direction of the track of the tornado, and another marking the direction of the preceding surface-wind.

Now, the mingling of these currents, or even the passage of one beneath the other, must, on account of their unequal temperatures, condense more or less of the moisture of the warmer current. This condensation is nearly always noticed. A cloud, often of intense blackness, accumulates just under the southern edge of the storm-cloud, and is usually prolonged horizontally to the northward along its base. If the cloud is near enough, so you can see beneath it, the parts farther in the rear will be seen to move rapidly in an easterly direction, just as the air-current moves which bears them. How can it be otherwise than that a gyratory motion shall result from such conditions? People frequently say, in describing a tornado, that "two dark clouds rushed together from opposite directions, and produced the tornado." This statement, if we are expected to construe it literally, seems somewhat absurd, since a cloud is always a passive element, moving only as the air moves in which it floats. That fragments of clouds and often quite large masses move toward each other is true; but tornadoes are not produced because of this, but on account of the *mutual resistance of two currents of air.* If two liquids or gases are brought together from different directions, a whirling motion is produced, as may be seen where two small streams of water flow together, or where a rock or fallen tree interrupts the direct movement of the water. This is but a necessary result of the combination of properties inherent in such a medium.

A volume of air, under pressure, escapes in the direction of least resistance: and, as there is a considerable pressure of the air where the two currents meet, an escape-current must form somewhere; and it forms, in accordance with the above law, in the direction of minimum resistance, obliquely upward to the east or north-east. As soon as this escape-current is developed, its position is at once located by a slender stem of vapor rapidly ascending obliquely; though, if the observer is at some distance, it seems to be suspended from the cloud above it, and even at times to descend toward the earth. Some of the downward movements of this 'funnel' are apparent only, the constantly ascending vapors sometimes condensing near to the ground, and at other times high in air. The tunnel-cloud is often absorbed into the cloud above, almost as soon as formed, the conditions necessary to its full development not existing.

In his excellent article on tornadoes, in the current number of the *Kansas City review of science*, Mr. John D. Parker speaks of the four characteristic motions of these meteors. These motions might be classified as horizontal and vertical. The horizontal motions are the linear, caused by the forward motion of the air-current governing the direction of the storm-cloud; second, the gyratory motion, caused, as above stated, by the mutual resistance of air-currents moving in different directions; third, the swaying motion, due partly to the varying pressure on different sides of the tunnel, and partly to the vertical or bounding motion of the tunnel. This latter motion would not have a very marked effect in producing the 'dentated edges' of the storm's path, if the tunnel-cloud were vertical instead of slanting. What causes the bounding motion it is difficult to say, but it certainly resembles electrical attraction and repulsion. This bounding movement was very marked in the tornado of April 18, 1869, which passed near this locality; but occurring, as it did, in the daytime, I could not distinguish the illumination of the lower part of the tunnel, which may sometimes be seen when these storms occur after dark, and which some think is due to electricity.

It is interesting to produce in miniature the horizontal motions of the tornado by the following simple experiment. When there is a good fire, let a small quantity of light, flaky ashes, or other light material, be sprinkled over the whole top of the cooking-stove. The heat forms quite a strong current, ascending mainly from the central parts toward the pipe. Cool currents flow in from all sides. Now, with the hand or a fan, produce local or opposing currents over the heated surface, and at once little tornadoes are developed, whirling the ashes several inches in the air. I have often produced them on both sides of the stove at the same time; those on the left moving as tornadoes in our latitude, and those on the right in the opposite direction. Now, are not the causes of the gyratory motion of the little whirlwinds on the stove, tiny as they are, the same in kind as those which produced the storms which devastated Marshfield, Grinnell, or Camanche? If this be answered in the affirmative, the rotation of the earth plays no direct part in causing the gyratory movement of this class of storms. Of course, the rotation of the earth causes the higher currents of air to move toward the north-east, instead of due north, as they pass from the equatorial to the arctic zone, and these currents determine the general linear movement of storms in our latitude; but this makes it proper to consider the gyratory motion an indirect result rather than a direct consequence.

S. A. MAXWELL.

Morrison, Ill., Oct. 9, 1883.

The chinch-bug in New York.

Why should Mr. Lintner conclude that the chinch-bug was brought to St. Lawrence county, N.Y., in a freight-car from the west? Harris corrects the erroneous idea that it is confined to the states south of 40° of latitude by demonstrating its occurrence in Illinois and Wisconsin, while Fitch's record of finding it in northern New York would justify us in assuming that it has always existed there, especially when we know that its range is much farther north. Packard found it on the top of the White Mountains; and it is to-day the most serious enemy that threatens the vast wheat-fields of Dakota. It seems to me more rational to consider this injurious manifestation in New York a result of undue increase of a species always there than to call it an invasion. Though we rarely hear of its injury in the Atlantic states, yet it is commonly met with where collecting is done near or in the ground, and in dry years is by far the most common Heteropter in grain and grass fields and dunes. This I know from personal experience, and have found it as far north as Boscawen, N.H.

Should it prove less susceptible to heavy and continued rains in New York than elsewhere, the fact will be remarkable. Such rains affect it most, however, in spring and early summer. My own interpretation of the interesting facts recorded by Mr. Lintner would be, that the species multiplied exceedingly during the very dry seasons of 1880 and 1881, and that the wet season, which it has so far braved (as it often does for a while in the west), will nevertheless tell on the hibernating bugs. In this view there is cause for encouragement rather than alarm. A careful survey would undoubtedly show, as Mr. Lintner suggests, that it exists in many places in the state where it has not yet been detected.

C. V. RILEY.

Washington, D.C., Oct. 24, 1883.

Unusual reversal of lines in the summit of a solar prominence.

On Oct. 17, between 3.45 and 4.30, local time (about 8.45 and 9.30 Greenwich time), a rather unusual phenomenon was observed at Princeton, in a prominence connected with the large and active group of spots which at that time was just passing off from the sun's disk.

The prominence had the very common form of a number of overlapping arches, with a sort of cap above them, or of a cloud connected by several curved stems to the chromosphere below. Its elevation was about 2′, and its extent along the sun's circumference a little less.

The peculiar features were the extreme brilliance of the cloud-cap at the summit of the prominence, and the perfect delineation of the form of this cloud in certain spectrum-lines, which ordinarily are reversed only at the base of the chromosphere; while, at the same time, certain other lines, which not unfrequently are reversed at considerable elevations, showed its form only very faintly, or not at all.

When I first came upon the prominence, in running around the sun's limb with the spectroscope, the brightness of the cloud-cap, as seen through the *C* line, was simply dazzling. I do not remember ever to have seen a prominence, or any part of one, quite so brilliant. At the same time, the line λ 6676.9 (which is in the same field of view with *C*, and is No. 2 of my catalogue of chromosphere-lines, — a line attributed to iron) also showed the top of the cloud quite as well and as brightly as is usual in *C* under ordinary circumstances. The chromosphere, also, was faintly visible in the same line; but the stems and lower portion of the cloud could not be seen at all in it. On turning to line λ 7055 (No. 1 of the catalogue), I was surprised and gratified to find the same appearances conspicuous in this line also. A careful search failed to show any other lines reversed below *C*.

Running up the spectrum from *C* to *D*, I could not find any lines showing the *top* of the prominence, though a considerable number were reversed in the chromosphere at its base. D_3, of course, showed the cloud-cap magnificently, but D_1 and D_2 only very faintly, though *distinctly* enough.

Between *D* and *b* the same remarks apply as between *C* and *D*. The corona-line, λ5315.9, was reversed at the base of the prominence a little more brightly than in adjacent parts of the chromosphere, but not at all in the cloud-cap. The magnesium members of the b group showed the cloud faintly in the same way as the sodium-lines; but in b_3 the form was a little more conspicuous.

Between b and F, *two* lines (λ 5017.6 and 4923.1, both attributed to iron) showed the cloud-cap as beautifully as either of the two below C. Numerous other lines were reversed in the chromosphere, but none of them showed the upper parts of the prominence. F appeared much the same as D_3.

Between F and G, *five* lines were noted as showing the cap. The most refrangible of them was Lorenzoni's f (λ 4471.2): the other four I did not identify at the moment, being in haste to reach the violet portion of the spectrum, and intending to examine them later, — an intention I was not able to carry out, on account of the intervention of clouds.

The lines $H\gamma$ (λ 4340) and h were, of course, conspicuous, each showing the whole of the prominence. I expected that H and K would do the same, but was disappointed. They both exhibited the cloud-cap finely, but I could not make out in them either the stems of the prominence, or the spikes and knots of the chromosphere; and yet both the lines were well reversed, not only in the chromosphere, but also on the face of the sun itself, over all the faculous region surrounding the spots. The ultra-violet line above K, first observed here a few weeks ago, was not visible.

There was no considerable motion-displacement exhibited by any of the lines, — something rather singular in so brilliant a prominence, — nor did its shape change much during the forty-five minutes of observation.

It is perhaps possible that this cloud was indentical with a remarkably brilliant facular *bridge*, which was observed two days before, spanning the largest of the spots which composed the group: still this is by no means certain. The instrument employed was the nine and one-half inch equatorial, with the Clark spectroscope carrying a Rutherfurd grating, of about 17,000 lines to the inch; first-order spectrum.

C. A. YOUNG.

Princeton, N.J., Oct. 22, 1883.

Sternal processes in Gallinae.

Having several times been asked the function of the long processes of the sternum as found in the Gallinae, I would make the following suggestions: —

If the sternum be examined *in situ*, the outer processes will be seen to extend far back, and well up the sides of the body, while the inner pair extend over the abdomen. The notches between the processes are closed by very tense, fibrous membranes. By this means a large area is afforded for the insertion of muscles with a minimum of bone. This must contribute slightly to diminish the weight of the posterior end of the body. Passing now to the muscles, we find that the great pectoral arises from the entire posterior border of the sternum, while the subclavius fills up the angle between the keel and body of the bone.

So much for the anatomy. What are the physiological results, and why could they not be attained in other ways? The results are an increased amount of pectoral muscle, and an increase in the length of the fibres, as compared with many other birds. Both of these are very desirable results for heavy birds of short, rapid flight, — the first, because with the increase in muscle comes a corresponding increase of force in the stroke of the wing; the second, because, by virtue of the long fibres, rapidity of contraction and a long stroke of the wing are secured. The rapidity is gained by all parts of the fibres contracting at once, whence the longer the fibre, the more quickly will a given amount of motion result. Both the first and the second are also aided by the fact that the first part of a muscular contraction is more powerful than the last part.

There is but one other way in which the same results, so far as the insertion of the muscles goes, could be attained; that is, by their origin from the ribs which lie under the sternum, as in the mammals, instead of from the overlapping sternum. To this, however, there is an all-powerful objection. If a man be watched while violently using his arms, it will be noticed that the upper part of the chest is held stationary. The pectoral muscles must have a firm point to pull from, in order to move the arms. As a result, respiration in the upper part of the chest is impeded, or, better, respiration is impeded by the diminished amount of tidal air. This principle is illustrated in the long, slow stroke, about twenty to the minute, of men trained to row great distances. The breathing is done, while the pectoral muscles are relaxed, at the normal rates. The same, only in a much greater degree, would hold good for birds. Were the muscles inserted into the ribs, respiration would be interrupted several times each second during flight: hence it is evident that the muscles could not be inserted into the ribs.

But again: why should the Gallinae require rapid powerful motions of the wings? Why should they not have long wings, and a comparatively slow stroke? This is forbidden by their habits. Long wings would be very cumbersome when the bird was on the ground, and absolutely worthless in much of the brush through which a grouse will fly with wonderful rapidity.

Therefore we may say that the processes are developed to give, with the greatest economy of material, a large area for the insertion of the pectoral muscles in such way as not to interfere with respiration, and that such area is required for the flight of the bird.

J. AMORY JEFFRIES.

A bifurcate tentacle in Ilyanassa obsoleta.

Some years ago, when collecting for my marine aquarium, in Raritan Bay, at Keyport, N.J., I obtained an Ilyanassa obsoleta of such a strange form, that I made a pencil-sketch and notes of it at the time. The left tentacle was bifurcated at the shoulder, or place where the normal tentacle abruptly narrows. The two sub-tentacles thus caused, seemed to be equally sensitive, as each was capable of separate and independent movement. Several instances have been long known to me of bifurcation of the caudal spine of Limulus; but the additional prong in every instance was functionless, and, in fact, an inconvenience. I have also seen malformed antennae in microscopic insects. As I have not heard of a similar instance in the mollusca, it seemed to me that the case should go on record.

SAMUEL LOCKWOOD.

Freehold, N.J.

The mechanism of direction.

Shortly after reading Professor Newcomb's paper in SCIENCE for Oct. 26, 1883, I had the pleasure of meeting him, and of discussing some matters of mutual interest in regard to subjective states of consciousness. It seems to me that the professor does not give sufficient weight to habit, and to unconscious cerebral action. In the strict sense of the word, one is not always *conscious* of the way he is going; for although he may avoid obstacles of any kind, yet he may pass some distance beyond his abiding-place by reason of mental pre-occupation. There are two lines of cerebral action going on at once, — one, the active mental study which engrosses him; the other, the unconscious action that keeps him out of danger from passing vehicles, or from other causes incident to city life. The limitation of direction which Professor Newcomb regards as exceptional, I consider as general: i.e., I believe that there are vastly more men who have no definite idea of lines as a standard of reference, than there are those who refer every thing in direction to such co-ordinates; just as there are many who never have any definite idea of the cardinal points of the compass, either as real or ideal points, and who never arrive at any clear conception of the bearings of familiar buildings, or the direction of streets, though they may live in the same city for years. The domination or tyranny of a fixed idea is explanatory of the difficulty which Professor Newcomb experiences. His ideal or subjective west was the domination of a fixed idea indelibly imprinted upon the super-sensitive cerebral cortex of youth, not necessarily associated with ideal or absolute direction, or with any system of horizontal lines, but an isolated conception, formed out of the perception of different positions, which in early youth could hardly be correlated with any abstruse reasoning. This idea of west, once ingrafted upon a developing brain, became a fixed factor, so dominant as to tyrannize over the understanding, and so persistent as to require some moments of study to dispel the illusion. This becomes evident from an analysis of his third division. The tyranny of the early idea has usurped control over the will, and, indeed, over the whole cerebral outcome. Even though the internal evidence corresponds with the external bearings to show that his preconceived west is really *not* west, but some other point, yet so strong is the power of this subjective idea, that by no process of argument can he rid himself of it. This is not uncommon, but by no means of frequent occurrence. But it is not a normal harmony of relation between the various reciprocal functions of the brain. It is likened to a habit formed in youth, so strong as to be ineradicable in manhood, and has been studied with much care by psychologists. Again: one may be mistaken as to direction, or become confused in tracing his route through the intricacies of his hotel, without associating such perversions with any states of subjective consciousness, so far as these states may involve the consideration or differentiation of the 'co-ordinates.' A man who is ignorant of the cardinal points of the compass, and who never can tell in which direction he is facing, loses his way because he has lost his bearings: the road was known by reason of the association of other facts, — a certain house just here, or a lamp just there, — and not because his horizontal lines have led him astray. In view of what we have learned of unconscious cerebral action, of habit, of the association of ideas, of the tyranny of a fixed idea, and of subjective states of consciousness leading on to abnormal objective conditions, it seems to me that Professor Newcomb's case is not an isolated one, and that what he has written of himself has already been written of and discussed.

HORATIO R. BIGELOW, M.D.

Washington, D.C.

Colorado climate.

For the benefit of other sufferers, please allow me to correct what is likely to lead to an erroneous impression, on reading Dr. Fisk's article on 'Climate in the cure of consumption,' as published in SCIENCE of Oct. 5. Dr. Fisk, in his very able article, like most of those who have written of the fitness of the climate of Colorado for consumptives, speaks as though Denver City were Colorado, and *vice versa*.

Now, this unintentionally misleading impression is calculated to do serious harm. During the late spring, and in summer and autumn, Denver and neighboring localities may be quite as pleasant and beneficial to the consumptive as localities south of the 'divide' that separates the waters of the Platte from those of the Arkansas.

But, during the cool and cold months, the Arkansas valley furnishes a very much better climate than can be found anywhere north of this divide in Colorado. It is scarcely necessary to state that the Arkansas valley furnishes all the necessary comforts of civilization, including convenient railroad transportation. As a rule, with rare exceptions, the consumptive should not sojourn in towns or cities, but rather in rural districts. But, should the consumptive prefer town or city life, Pueblo, Cañon City, and other places in the Arkansas valley, afford ample accommodation.

Having long been a sufferer myself, and having sought health in many portions of North America, I speak of the before referred to localities from observation and experience, and without prejudice or pecuniary interest.

Q. C. SMITH, M.D.

Austin, Tex., Oct. 18, 1883.

[Dr. Fisk's article was written with especial reference to Denver, as the necessary data exist for that place, furnished by the records of the signal-service station: these do not exist for localities in the Arkansas valley. — EDITOR.]

A BIOGRAPHICAL HISTORY OF ASTRONOMY.

Heroes of science — astronomers. By E. T. C. MORTON, B.A., scholar of St. John's college, Cambridge. London, *Society for promoting Christian knowledge*, [1882.] 341 p. 16°.

FROM the title, 'Heroes of science — astronomers,' one might expect to find in this little book an account of the lives and a eulogium of the characters of the greatest astronomers, with some general indication of the nature of their discoveries. This expectation would be partially corrected by the opening paragraphs of the preface: —

"The primary object of this little book is, as its name implies, to give some account of the lives of the chief astronomers. But it is impossible to leave in the mind of the general reader any clear notion of their characters, without giving some account of their work. A good deal of space is therefore taken up with explanations of their discoveries; but, as this is only of secondary importance, the explanations are given in a popular manner, and no mathematics is introduced, except in ten pages (172–182), where a knowledge of the first book of Euclid and of the elements of algebra is assumed.

"The book may possibly be useful as an introduction to the study of astronomy, and, in this aspect of it, it is hoped that it may be helpful in two respects: First, by putting before the student the personal difficulties which the first investigators of the law of the stars met with, and the struggles they passed through to overcome them, whereby a human interest is given to the study of their work; and secondly, by clearly indicating the nature of the problems to be solved by the science."

In point of fact, however, the book does much more than this: it presents a clear, connected, readable account of the chief steps in the progress of astronomy from the earliest times to the present day; and while the lives of the astronomers, judiciously inserted and as a rule well told, greatly heighten the interest of the story of the science, the reader always feels that they are only the accidents of the book, while the unfolding of the successive triumphs of astronomy, and the exposition of its laws, objects, and methods, is its constant purpose.

Interesting and readable as the book is almost throughout, we nevertheless think the author mistaken in regarding it as well adapted to serve as an *introduction* to astronomy for non-mathematical readers. It is true that only very elementary mathematics is explicitly introduced; but few readers who are not either equipped with the habits of thought bred by mathematical study, or possessed of some familiarity with the outlines of astronomy, can follow intelligently and with interest the discussion of complicated motions. To young people who have gone through an elementary course in astronomy, on the other hand, the book before us will be most instructive and stimulating. The subject is vivified, not only by the presentation of the lives, so full of inspiration, of the great founders of the science, but also by a far clearer view of its progressive development than an ordinary text-book can afford. And the impression is not weakened by the introduction of insignificant details, or of merely statistical information. Not that details are avoided when they are necessary to the exposition or illustration of a great law, or of an important phenomenon: on the contrary, one is surprised at the number and diversity of the points which are explained, and in general clearly and satisfactorily explained. The author has not refrained from giving simple expositions of mechanical and physical laws when they are essential to the clear understanding of astronomical doctrines. By explaining the laws of motion, for example, and insisting on their fundamental importance, he puts the reader in a position to understand the great problem of physical astronomy, and to appreciate its solution. In connection with spectrum analysis, a little space devoted to the analogy between sound and light makes the subject clear to the average reader. And many other instances might be mentioned.

As the character of the book does not make it incumbent upon the author to present any thing like a complete survey of even the most prominent astronomical facts, he is able to give a much fuller exposition of the central points in the theory of astronomy than one would expect to find in so limited a space, and to give intelligible accounts of many things having a direct connection with these central principles, which are usually passed over with a bare mention in small works on astronomy. Thus, more than eighty pages are devoted to Newton, only a small portion of which is biographical, a whole chapter of fifty pages being specifically devoted to the Principia. And pretty full accounts are given, for example, of Herschel's theory of stellar distribution, of the nebular hypothesis, of Laplace's proof of the stability of the solar system and Lagrange's previous attempts in that direction, and of the recent researches of Mr. G. H. Darwin.

It would be quite possible to point out minor defects in the book. There is occasionally (but very seldom) an attempt to explain what cannot be satisfactorily explained in a popular manner; once in a while the demonstrations, which are usually in excellent and attractive form, are made pedantically stiff; there are a few inaccuracies, chiefly of expression; and there are possibly a few cases of Sunday-school moralizing from insufficient premises. The only instance we have noticed of unfairness in the historical portion is in the passage relating to the Mohammedan astronomers. Scant justice is done them; and the author permits himself to combine silliness with injustice in saying that 'it illustrates the slavish stupidity of the race,' that a discovery made by an Arab astronomer in the tenth century was afterwards forgotten by them! A grave defect, but one which can easily be remedied in a new edition, lies in the lack of an index, — an omission which seriously impairs the value of this very interesting and useful work. In conclusion, lest we should leave the impression that the book can be read with advantage only by students, we would say that the chapters which combine in the highest degree biographical with scientific interest, — those on Copernicus, Tycho Brahe, Kepler, and Galileo, — and many other parts of the book, may be read with great pleasure and profit by a very wide circle of readers.

PROCTOR'S GREAT PYRAMID.

The Great Pyramid: observatory, tomb, and temple. By R. A. Proctor London, *Chatto & Windus*, 1883. 323 p., illustr. 8°.

This last work of Mr. Proctor's fertile and ingenious mind is of uncommon and enduring interest. To begin with, it concerns the most uncommon and the most enduring work of man, — the Pyramid of Cheops, whose mighty form has for nigh five thousand years remained the least changed and the least comprehensible of all man's great deeds. Then it comes happily into a discussion which is by far the most curious that has recently vexed the minds of learned men. There are plenty of paradoxical folk on the lower confines of science, — circle-squarers, Symms'-hole hunters, and the like; but men of learning, especially astronomers and mathematicians, are a hard-headed lot. The crack-brained do not often find their way up to their upper heights, for evident reasons. But it is a set of these really learned people that has given us the sect of the pyramid worshippers, — the most extraordinary cult of a century, that, of all the Great Pyramid has ever seen, has been the most fertile in religious whims.

Active proselyting not yet having begun, perhaps for want of needed martyrs, the general public has as yet heard little of the pyramidalists or their faith. This is surprising; for their faith has more miracles 'to the acre' than Mormonism, and these miracles are as solid and ponderable as the pyramid itself. They are before our eyes: hundreds of pages of mathematics are needed to express them, and they have all the cheap look of certainty which the public associates with algebraic formulae. The following is in brief the history of pyramidalism, the only mathematical *ism* of the nineteenth century. Many years ago a Mr. John Taylor, pondering on the matter of the Great Pyramid, — which, by the way, he had not seen, and never saw, — came to the extraordinary conclusion that the architects of the structure recorded in its proportions, and in the arrangement of its chambers and passages, certain religious and astronomical truths, which they intended should, after thousands of years of secrecy, be divulged in our day. Mr. Taylor, being otherwise unknown to fame, though clearly entitled by this tour of imagination to rank high among speculators, found no able advocates of his notion, until his book came in the way of Professor Piazzi Smyth, astronomer royal of Scotland, one of the most distinguished astronomers of our time. Captivated with this daring hypothesis, Professor Smyth visited the Great Pyramid, spent many months in a careful and costly survey of the structure, and, in his successive writings on the subject, has not only re-affirmed the conclusions of Taylor, but immensely extended the range of his conclusions. Briefly stated, his position is this: some three thousand years or more before our era, a Semitic prince, probably Melchizedek, that vast shadow of the time, inspired by God, went to Egypt, gained an intellectual mastery over King Cheops, and forced him to build this pyramid, which was designed to "keep a certain message secret and inviolable for four thousand years, . . . and in the next thousand years it was to enunciate this message to all men; . . . and that part of the pyramid's usefulness is now beginning."

This 'message' is thus summed up by Mr. Proctor: —

"The Great Pyramid was erected, it would seem, under the instructions of a certain Semitic king, probably no other than Melchizedek. By supernatural means, the architects were instructed to place the pyramid in latitude 30° north; to select for its figure that of a square pyramid, carefully oriented; to employ for their unit of length the sacred cubit, corresponding to the twenty-millionth part of the earth's axis; and to make the side of the square base equal to just so many of these sacred cubits as there are days and parts of a day in a year. They were further, by supernatural help, enabled to square the circle, and symbolized their victory over this problem by making the pyramid's height bear to the perimeter of the base the ratio which the radius of a circle bears to the circumference. Moreover, the great processional period, in which the earth's axis gyrates like that of some mighty top around the perpendicular to the ecliptic, was communicated to the builders with a degree of accuracy far exceeding that of the best modern determinations; and they were instructed to symbolize that relation in the dimensions of the pyramid's base. A value of the sun's distance more accurate by far than modern astronomers have obtained (even since the last transit of Venus) was imparted to them, and they embodied that dimension in the height of the pyramid. Other results which modern science has achieved, but which by merely human means the architects of the pyramid could not have obtained, were also supernaturally communicated to them; so that the true mean density of the earth, her true shape, the configuration of land and water, the mean temperature of the earth's surface, and so forth, were either symbolized in the Great Pyramid's position, or in the shape and dimensions of its exterior and interior. In the pyramid, also, were preserved the true, because supernaturally communicated, standards of length, area, capacity, weight, density, heat, time, and money. The pyramid also indicated, by certain features of its interior structure, that when it was built the holy influences of the Pleiades were exerted from a most effective position, — the meridian through the points where the ecliptic and equator intersect. And as the pyramid thus significantly refers to the past, so also it indicates the future history of the earth, especially in showing when and where the millennium is to begin. Lastly, the apex or crowning stone of the pyramid was no other than the antitype of that stone of stumbling and rock of offence, rejected by builders who knew not its true use, until it was finally placed as the chief stone of the corner. Whence, naturally, 'Whosoever shall fall upon it' — that is, upon the pyramid religion — 'shall be broken; but on whomsoever it shall fall, it will grind him to powder.'"

It would require all the space of this number of Science to print in full array the evidence on which these conclusions are rested. At every step the able astronomer royal of Scotland has fortified his conclusions by careful measurements of the Great Pyramid. His method of working is as follows: having found that the unit of measurement is a certain length, about an inch, which he terms the 'pyramid inch,' he seeks, in the various measurements of the structure, for correspondences in number of these units with natural and historic units, the distance of the sun, the radius of the earth, etc. Finding a correspondence, or *a close approximation to a correspondence*, he assumes that this ratio was intended by the builders to be a statement of this truth. At first sight, the number and accuracy of these correspondences is simply astounding: they look like insuperable facts. Moreover, the measurement of the sun's distance, and perhaps some other ratios from the Great Pyramid, may turn out in the end to be closer to the truth from the pyramid revelation than they are to our present measurements.

After a sagacious review of the principal coincidences, and an effort to show their generally unintended nature, Mr. Proctor proceeds to develop his own view, which is, in effect, that the pyramids were built for astrological observatories, designed for the casting of the horoscopes of the successive kings. He shows clearly, and we believe was the first to show, that early astronomy was astrological in its aims, and that the pyramid, when it had been carried up to half of its height, would afford the best possible structure for astronomical work of that time. His ingenious, and we must say convincing, argument requires us to assume a much more advanced state of astronomical and geodetic science in those days than many would be willing to admit. Still, the old Semitic civilization is a vast unexplored realm: it is a vain fancy that we yet know what it contained. It is easier to give to it any thing in the way of learning than to accept the monstrous scheme of bungling prophecy that the pyramidalists offer in its stead.

The student of science may have something beyond the entertainment that all readers will find in this book, and the literature of which it will form an important part. He may find in the controversy a suggestion of certain dangers that await all work of a theoretic kind. All the work of extending our conceptions of natural phenomena, all the work of true science, must be carried on by the method of coincidences. A fact, or series of facts, is compared with other facts or series, and, from their observed identities, relations are inferred. The use of this method, under rigorous scrutiny, has given us our modern science, and must give us all that is truly scientific in the time to come. The incident of the Great Pyramid inquiry may well lead us to notice certain dangers in this method. A large part of the facts with which the naturalist has to deal has for him the danger that the Pyramid of Cheops has for the mathematician. Between the thing in hand and other things, there is a practically infinite number of relations. If he sets out on his inquiry with a mind to find resemblances of a certain kind, this liberal nature is sure to gratify him. Nothing but the most rigorous correction of the reasons for an opinion by the reasons against it will keep him safely on his way.

The more fixed the opinion that guides the student in his work, the surer he is to find in the infinite that any object offers the facts to support his views. This is the great danger that lies in the way of many who are seeking to advance the development hypothesis in biology. Having become possessed with the conviction that certain things are to be found, they will see them as Smyth sees revelation in the stones at Ghizeh.

There are some faults to be found with the *making* of this book. More than one-third of it consists of separate essays on the origin of the week, — Saturn, and the sabbath of the Jews; astronomy and Jewish festivals; the history of Sunday; and astrology, — all very interesting in their way, but they are not represented in the title. There is no proper table of contents, and no index. The British seem determined to leave this work of opening their modern literature to students, altogether in the hands of the Index society.

The book is written in the admirable didactic English of which the author is a master.

MINOR BOOK NOTICES.

Man before metals. By N. Joly. New York, 1883. (International science series, no. 45.) 8+365 p., illustr. 8°.

The author of this attractive volume, unlike many European writers on archeology, gives but little space to the subject of North-American antiquities; and, of the one hundred and forty-eight illustrations, not one represents a characteristic stone implement of this country. The little that our author finds to say under the comprehensive title of 'Prehistoric man in America' is included in twelve pages, constituting chapter vii., and is mainly a review of Squier and Davis's Ancient monuments of the Mississippi valley, with brief reference to certain discoveries recorded so long ago as the publication of Gliddon and Nott's Types of mankind. Mr. Joly might readily have done far better. No mention is made of the vast amount of material gathered within the last decade, that bears so strongly upon the vexed question of man's antiquity on this continent. The scores of publications of the Smithsonian institution, the invaluable reports of the Peabody museum, and the transactions of our learned societies generally, have been quite overlooked; and a vain attempt has been made, in lieu thereof, to bolster up the claim of antiquity of America's earliest people by reference to the mounds of the Ohio valley, many of which have recently lost their claim to a pre-Indian origin, and others, doubtless, will yet be shown to have been erected by the ancestors of our modern redskin. As a *résumé* of European archeology, it is valuable, but not otherwise. To the American students of the science it will prove disappointing.

Hydraulic tables for the calculation of the discharge through sewers, pipes, and conduits; based on Kutter's formula. By P. J. FLYNN. New York, *D. Van Nostrand*, 1883. (Van Nostrand's science series, no. 67.) 135 p. 24°.

KUTTER'S formula for determining the velocity of flow of water is one of the class which has the general form $v = c\sqrt{rs}$, where r is the ratio of the cross-section a to the wetted perimeter, and s is the sine of the slope; but the coefficient c is of such a complex form, that the application of the formula to definite problems in water-supply and sewerage is somewhat tedious. This collection of tables is designed to facilitate the work, and gives values of r, $c\sqrt{r}$, and $ac\sqrt{r}$, for circular and egg-shaped sections, and of s and $\sqrt{s}$ for different slopes. The coefficient of roughness or friction used is .015, and a number of examples make clear the use of the tables. Engineers who have such work in their practice will find these tables convenient.

Chemical problems, with brief statements of the principles involved. By JAMES C. FOYE. New York, *Van Nostrand*, 1883. (Van Nostrand science series, no. 69.) 6+141 p. 24°.

THE value of chemical problems as a practical illustration of the rules of stochiometry is recognized by every teacher of chemistry. A thorough knowledge of chemical arithmetic is constantly required in the laboratory, and it can only be gained by actual practice in the solution of problems. The convenience of having a collection of examples at hand will therefore be appreciated by teachers; and this book will doubtless supply a deficiency to those who prefer the problems arranged independently of the text-book. A great variety of examples are presented, with very full illustrations of the relations which exist between the factors and products of chemical reactions, beside calculations of atomic and molecular weights, specific and latent heat, specific gravity and vapor density. Examples are also introduced on the metric system of weights and measures, thermometric scales, and the laws of Mariotte and Charles.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Origin of the lines A and B in the spectrum. — M. Egoroff, by experiments at the physical laboratory of the University of St. Petersburg, has shown that the lines of the solar spectrum known as *A* and *B* are due to the oxygen of our atmosphere. He employed a tube twenty metres in length, closed with glass plates, in which tube the gas under investigation could be condensed under pressures of fifteen atmospheres or less, proper care being taken to dry it thoroughly. The telluric character of these lines has been generally admitted, but has of late been called in question by Mr Abney, who suggested that they might be due to cosmical hydrocarbon gas of some kind, diffused through space in accordance with Siemens's theory. M. Egoroff sets this question at rest, having determined by direct experiment that none of several different hydrocarbons tried gives any such bands, while oxygen unmistakably does give them. — (*Comptes rendus*, Aug. 27.) C. A. Y. [327

On the assumption of a solar electric potential. — Werner Siemens discusses the hypothesis proposed by his brother (Sir W. Siemens), that the sun has a high electric potential, due to the friction of the dissociated matter which, according to his theory, is continually flowing in at the sun's polar regions to replace that which, after combustion, is thrown off at the sun's equator. The paper is an important one, but too long to be fairly summarized within our limits. A considerable portion of it is devoted to an endeavor to obviate one of the most serious objections to Siemens's theory of the solar heat; namely, the objection based on the resistance to planetary motions which would result from a cosmical interstellar medium of the necessary density. Werner Siemens argues that the particles of matter passing off from the sun's equator would continue to revolve around the sun as they receded from it, and at any distance would have the same velocity as a planet at that distance, and so would offer no resistance. The paper is, however, mainly occupied with the planetary consequences of solar electrification. — (*Phil. mag.*, Sept.) C. A. Y. [328

MATHEMATICS.

Development of real functions. — The exact title of this paper, by M. J. P. Gram, is 'The development of real functions in series, by the method of least squares.' M. Gram's paper is an exceedingly interesting one, but unfortunately one which cannot be more than briefly referred to in this place, as a suitable notice of it would require the reproduction of a great deal of algebraical work. The principal problem which M. Gram proposes to solve is stated as follows: let there be given a series of arguments, x, and two corresponding series of quantities, o_x and v_x. These last quantities are all real, and, further, the v_x are all positive. Then in a series which contains known functions of x, — viz., $y_x = a_1 X_1 + a_2 X_2 + \ldots + a_n X_n$, — the coefficients are to be so determined that $\Sigma_x v_x (o_x - y_x)^2$ shall be a minimum. In the first part of the paper, the author gives applications of his process to Fourier's series, spherical harmonics, and cylindrical functions. The second part refers almost entirely to the convergence of certain series; but without quoting much that is obtained in the first section, and defining many symbols, it would be impossible to give here a suitable or intelligible notice of this second section. — (*Journ. reine ang. math.*, xciv. 94.) T. C. [329

ENGINEERING.

Economical pumping-engines. — Mr. C. T. Porter reports the duty of the Gaskill engines at Saratoga as 106,000,000 pounds, raised one foot high, per 100 pounds of hand-picked coal. The Corliss engines at Pettaconsett, Providence, R.I., gave a duty of 113,-271,000; and the Pawtucket engines have an average, for the year 1882, of 113,500,000. The slip of valves is reduced to one-half of one per cent. — (*Mech.*, July 21.) R. H. T. [330

Consolidation of bulky materials. — A steam-hammer has recently been applied to the consolidation of bulky materials in steel moulds. The materials are usually organic, often fibrous, and one blow generally does the work. Four blocks per minute are made; 3,000 pounds of sawdust are compacted into blocks each hour. Bran is thus made denser than flour, and can be preserved indefinitely. Stone is made from earth or sand, and weighing 160 pounds per cubic foot. The following are results so obtained: —

	Cubic feet per ton.		Weight per cubic foot.	
	Unpressed.	Pressed.	Unpressed.	Pressed.
Bran	172	34	13	65
Meal	64	37	35	65
Sawdust . . .	448	34	5	65
Tanbark . . .	140	35	16	64
Cotton (baled) .	93	40	–	56
Hay " .	160	34	14	65
Bitum. coal-dust.	44	28	50	80

— (*Industr. world*, June.) R. H. T. [331

Economy of steam-boilers. — William Kent reports, to the American society of mechanical engineers, the results of a series of tests of fuels in various ways, and under various forms of boilers. He gives the following as relative values of fuels determined by burning under the Babcock & Wilcox boilers: —

Welsh bitum.	109.6.
Scotch bitum.	109.5.
Cambria, Penn., semi-bitum. . . .	91.2.
Pittsburgh, Penn., bitum.	99.5.
Ohio bitum.	84.9.
Vancouver's Island	85.7.

The paper is long and unusually complete. — (*Ibid.*) R. H. T. [332

METALLURGY.

Bessemerizing copper mattes. — Pierre Manhès claims to have overcome all the difficulties in Bessemerizing copper matte, and to have charge of an establishment which is, at the present time, successfully making copper on a commercial scale. He melts the ore in a suitable cupola furnace, casting the matte produced into a Manhès converter, when, under the action of a high-pressure blast, it is rapidly transformed into 98 % to 99 % black copper. The Manhès works consist of three cupolas of twenty-five to thirty tons' capacity per day; two small cupolas for remelting the matte in case of need; three Manhès converters, treating a ton and a half of matte at each operation, and each converter makes twenty-two to twenty-four operations per day; and the necessary blowing-engines. Manhès claims that cost of labor is reduced to a minimum, because operations last only a few minutes, and large quantities of metal are handled. The cost of fuel is low; because no fuel is needed to bring the matte forward to black copper, except that used for the blowing-engine. The saving in cost over the Welsh or Swansea process, according to local conditions, is from 50 % to 75 %. — (*Eng. min. journ.*, June 30.) R. H. R. [333

AGRICULTURE.

Seed-testing. — Comparisons between the germinating and vegetating powers of seeds, made at the New-York agricultural experiment-station, show that the two are by no means identical. Many seeds which were capable of putting forth a radicle failed to vegetate sufficiently to form cotyledons, under the favorable conditions of a testing-apparatus. In eleven tests, with four species of seeds, from ten to forty-six per cent of the seeds germinated, but failed to vegetate. — (*N. Y. agric. exp. stat. bull.*, lxii.) H. P. A. [334

Sulphuric acid as a fertilizer. — The use of sulphuric acid has been proposed as a means of rendering the constituents of the soil soluble. Experiments by Farsky on summer rye, grown in boxes, showed no advantage from the use of sulphuric acid or of acid sodium sulphate. When the soil was kept dry, a slight decrease in the production of grain was noticed as the result of the manuring. The soil was a clay soil, and the sulphuric acid was sprinkled upon it in the concentrated form until it was distinctly moist. A hundred grams of acid were used to thirty-five hundred grams of soil. — (*Biedermann's centr.-blatt.*, xii. 447.) H. P. A. [335

GEOLOGY.

Lithology.

Determination of the felspars in rocks. — Professor J. Szabó's method of determining the felspars in rocks was published at Budapesth in 1876; but he has recently placed it before the English reading public in a paper read at Montreal last year. His method consists chiefly in determining the coloration of the flame by the felspars, and their fusibility. This method, with the addition of Boricky's micro-chemical process, is further used by Szabó for the determination of other silicates. For the details of the process, reference is to be had to the original papers. — (*Proc. Amer. assoc. adv. sc.*, 1882.) M. E. W. [336

Laterite from Huranbee, Pegu, India. — This is described by Dr. R. Romanis as an aqueous rock of a bright red color, friable, and full of cavities. It is stated to be composed of 31.44% of quartz sand, 13.27% of soluble silica, 36.28% of ferric oxide, 9.72% of alumina, and 8.83% of water. When the sand is examined under the microscope, it is seen to be water-worn. Laterite is much used in building and road-making on account of its hardening when exposed to the air. — (*Trans. Edinb. geol. soc.*, iv. 164.) M. E. W. [337

MINERALOGY.

Minerals from Amelia county, Va. — In a vein of granite which for the past few years has been worked for mica, a few rare and interesting minerals have been found, and are described by William F. Fontaine. Columbite occurs in crystals of large size, and rather rarely a manganese variety of a chestnut-brown color is found. This latter has a tendency to assume a fibrous structure. Orthite is found abundantly in long, bladed crystals. The most interesting mineral found at the locality is microlite, occurring both in crystalline masses of large size, and in distinct crystals: the latter are octahedrons, modified by small cubic, dodecahedron, and tetragonal-trisoctahedron faces. Analysis has shown that the mineral is essentially a calcium tantalate. Monazete, another rare and interesting mineral, is found abundantly at the locality, sometimes in masses weighing several pounds. Analyses have shown that this has the composition of a normal phosphate of the cerium metals, while the thorium, which is most always present, and abundantly in the monazete from Amelia, is due to an admixture of a silicate of thorium. Helvite, a rare silicate of manganese, beryllium, and iron, containing sulphur, is found sparingly associated with spessartite (manganese garnet). — (*Amer. journ. sc.*, May, 1883.) S. L. P. [338

METEOROLOGY.

Thunder-storms.—A special investigation of thunder-storms has been made in Bavaria and Würtemburg since 1879. In 1882, in Bavaria there were 252 stations, which number, distributed uniformly, would give a mean distance between stations of about ten miles. To each of these stations, cards were sent, having questions calling for the time of beginning and ending of thunder, hail, or rain; also, the direction from which the storm came, and the direction and force of the wind.

These investigations show: 1°. That the thunder-storm, while not an accompaniment of a cyclone, still appears with smaller secondary depressions, or spurs of great depressions, which are so flat that they do not produce any strong wind. Of special force is the thunder-storm in the ridge of high pressure dividing two great depression-regions from each other. 2°. That the line upon which simultaneous electric discharges take place encloses a space which has, in most cases, great length but little width, and which stands at right angles to the line of progress of the storm. Such simultaneous discharges have been observed over a region 300 km. (186 miles) broad and about 40 km. (25 miles) deep. 3°. That special regions for thunder-storms are marshy low grounds between the Mediterranean or other smaller bodies of water, and the Alps; also the western declivity of the Bohemian forest. 4°. That in cases where the origin of the storm can be well determined, within the region of observation, it is found that electric discharges take their beginning along a long line simultaneously; and it is conjectured, that the disturbance of the electric equilibrium, by the first discharge, propagates its influence from cloud to cloud, and causes simultaneous outbursts in different places. 5°. Heat-lightning is due to the presence of a storm at a great distance. In one instance it was traced to a storm 270 km. (167 miles) distant. 6°. Arranging the storms according to their frequency at each hour of the day, we find the hours from midnight to eight A. M. of little activity, a very rapid rise from eight A. M. to four P. M., and nearly as rapid a fall to midnight.

The above results show the importance of a detailed observance of these meteors. It is hardly probable that we can learn particulars of these so-called local storms, by observing them at stations a hundred or more miles apart. The various state weather-services have an excellent opportunity for undertaking such observations. It may be possible to learn the movements of these storms over large areas, and thus to give warning of their approach three or even four hours in advance. — (*Zeitschr. met.*, June.) H. A. H. [339

GEOGRAPHY.

Bureau of commercial science. — The Ministry of commerce in France has just instituted a new bureau, which is to be directed by M. Renard, formerly librarian of the Ministry of marine. This bureau is intended to bring together the publications, letters, travels, and information bearing on commerce, industry in foreign countries, navigation, etc., which come to the authorities in various ways, and selections and translations of documents from foreign sources and collections. Those considered of importance will be printed for the public use. — (*Soc. de géogr. Paris*, June.) W. H. D. [340

Notes on population. — The late census of Monaco shows the principality to contain 9,108 inhabitants, of which more than one-third are French. —— Born Parisians are always in a minority in that city, numbering, according to the latest figures, about thirty-two per cent of the population. The city contains 164,038 foreigners, of which, in round numbers, 45,000 are Belgians, 31,200 Germans, 21,600 Italians, 21,000 Swiss, 10,800 English, 9,250 Dutch, and about 5,000 each, Americans, Russians, and Austrians. Twenty per cent of the total increase of the population of Paris during the years 1876–81 is due to the increase of resident foreigners. —— The stagnation of the population of France is exciting much attention, and even apprehension. It is sufficiently evinced by its proportional ratio to the Anglo-Germanic population of Europe. This in 1700 was three to three, or fifty per cent; that is to say, France equalled in population the whole of the group referred to. In 1881, however, her ratio was as three to seventeen; or, if the Anglo-Germans of the United States be counted in, it was only three to thirty, or about ten per cent. —— The population native to the Marquesas Islands in 1855 was about 12,000: at present it has diminished to 5,700. —— The population of Tunis, it seems, has been greatly exaggerated. Instead of five or even two and a half million, as has been accepted for some years, the late investigations of M. Perpetue show that the total figure, probably, should not exceed 1,400,000, of which about 36,000 are foreigners. — (*Bull. soc. géogr. Mars.*, June.) W. H. D. [341

(*North America.*)

Fisheries of British Columbia. — Foreign vessels have been officially warned from taking or curing fish within three miles of the coast of the province. The value of the catch for 1882 was $1,842,675, and of vessels, nets, etc., $229,600. Twenty canneries and other land-stations are assessed at $402,000. They employed, in 1882, 5,215 hands and 79 vessels; and the increase in value, over 1881, of the product, was over thirty per cent. More than twelve million cans of salmon and nearly six hundred thousand pounds of herring were put up during the season. — W. H. D. [342

Salmon-fisheries in the north-west. — The output of canned salmon on the Columbia River, at the close of the season, was 629,438 cases, and the disbursements to the fishermen employed were $1,550,000. In 1882, 541,300 cases were put up on the Columbia. About 17,500 cases had been put up on the Fraser River to Aug. 1; but, for the complete returns, details for this and the Alaskan region are not yet received. The total pack on all rivers on the north-west coast of America, in 1882, was 941,187 cases, each containing the equivalent of forty-eight pounds of canned fish, or at least double that amount of fresh fish, equal to about five million individual salmon of ten pounds each. — W. H. D. [343

(*South America.*)

Notes. — C. de Amezaga, in the Bulletin of the Italian geographical society, gives a general description of the Galapagos, with a map, from investigations by Wolf and Icaza, and an historical account of them, and the endeavors to colonize them. It appears that there is actually a small settlement on Chatham Island of recent date. Older ones on Floriana all came to an unfortunate termination. —— The Instituto Argentino meditates an expedition to southern Patagonia, to be directed by Capt. Carlo Moyano, who lately crossed the Patagonian desert from Santa Cruz to Port Deseado. —— The death of Bartolomeo Lucioli is reported on the 9th of June, while on his way from Lisbon to Para. The deceased, who was about fifty years of age, had been a civil and military officer in the Peruvian service, but was afterward more distinguished as an explorer of the Ucayali and upper Amazons, and as the collector of a precious ethnological exhibit now in the Ethnological museum at Rome, relating to the inhabitants of this region. —— The commission for determining the boundary between Venezuela and Brazil, in the vicinity of the Orinoco, has returned to Rio Janeiro. They bring valuable geographical material, but have suffered severely from fever and other evils attendant on such explorations in South America. —— Lovisato, one of Bove's companions, has read a paper before the Italian geographical society on his geological researches in Patagonia and Tierra del Fuego, describing the glaciers of the latter region, and suggesting reasons for the supposition that the antarctic region is occupied by land rather than sea. —— Some notes on New Grenada, made in 1617–30 by Hubert Verdonck, a Belgian Jesuit, appear in the Anvers Bulletin. They contain a few ethnological and historical details of interest; but even at that time the aborigines had totally disappeared from the vicinity of Carthagena and Panama. —— A letter from the French meteorological station at Orange Harbor, in the *Revue géographique* for July, while containing no information of importance, is accompanied by two characteristic illustrations of Fuegian people, and one of their dogs. — W. H. D. [344

BOTANY.

Sylloge fungorum. — The second volume by Prof. P. A. Saccardo, of more than eight hundred pages, includes all the remaining species of Pyrenomycetes not treated in the first volume, together with an index of all the genera and species of the order. There are also several pages of addenda to both volumes, including the species published up to a very recent date. In fulness and general arrangement, the present volume has the same merits as its predecessor. Vol. iii. is announced to appear in 1884, and will include the Sphaeropsoideae, Melanconieae, and Hyphomycetes. — W. G. F. [345

Illustrations of British fungi. — This comprehensive and finely executed work by M. C. Cooke has now reached the end of the second volume, including eighteen parts and an index. The two volumes already issued include figures of all the leucosporic species of Agaricus known to occur in Britain, except twenty-six little-known species, three hundred and seventy-eight species with varieties being represented — a considerably larger number than is included in the works of Sowerby, Bulliard, or Krombholz. The work will be continued, and contain plates of the remaining sections of Agaricus. — W. G. F. [346

Ascospores in the genus Saccharomyces. — In the reports of the Carlsberg laboratory, Hansen gives a *résumé* of his researches on the formation of ascospores in the different forms of Saccharomyces. While in general he agrees with Rees's views, he denies the possibility of distinguishing species of Saccharomyces by the ascospores; and, in fact, he is hardly inclined to admit the specific value of the different forms described by Rees. Hansen's experiments were made with cultures of single spores obtained by a process of dilution, which he describes in detail; and the purity of the cultures was recognized by the formation, on the walls of the culture-flasks, of a single spot formed from the growth of one spore. He also adopted, with good results, Koch's method of gelatine culture. While the ascospores of the different so-called species of Saccharomyces cannot be distinguished by their shape, Hansen found that there was a difference in the time of their germination when exposed to different temperatures; and he gives a series of curves to represent the results of his experiments with regard to the temperature in six different forms. The curves all have a similar form; but the maxima and minima vary with the different species, the minimum being between ½° C. and 3° C., and the maximum about 37½° C. There follows a discussion of what Pasteur calls Torulae, which resemble species of Saccharomyces, but are separated from that genus by Hansen, because he found that they did not produce ascospores. The paper concludes with an account of diseases of beer caused by certain alcoholic ferments. — W. G. F. [347

ZOÖLOGY.

Worms.

Homology of the nemertean proboscis and the chorda dorsalis. — In an article on the ancestral form of the chordata, Hubrecht defends the following speculative thesis: "According to my opinion, the proboscis of the nemerteans, which arises as an invaginable structure (entirely derived, both phylo- and onto-genetically, from the epiblast), and which passes through a part of the cerebral ganglion, is homologous with the rudimentary organ, which is found in the whole series of vertebrates without exception, — the hypophysis cerebri. The proboscidean sheath is comparable in situation (and development?) with the chorda dorsalis of vertebrates." Without adding new facts, but merely basing his arguments on what is already known, the author defends his hypothesis with great ingenuity. His chief argument is, that the proboscis and the hypophysis are both anterior ectodermal invaginations, and are homologous. His use of terms is misleading. By 'proboscis' he designates apparently both the free portion of the proboscis and its sheath; by 'proboscidean sheath,' on the contrary, the posterior portion of the proboscis, which has no sheath, and is not free. At least, his descriptions became intelligible to the reporter only on that assumption. The posterior unfree part of the proboscis he considers the homologue of the notochord. The vertebrates are not connected with the annelids; but, on the contrary, the two lateral nerves of lower worms have united *dorsally* to make the central nervous system of vertebrates, *ventrally* to form the ganglionic chain of annelids and their derivatives. In the second half of his paper, the author endeavors to strengthen his position by comparisons between other organs in nemerteans and vertebrates. [It is possible that Hubrecht's hypothesis will be verified; but the objections to it come to mind so immediately, and in such throngs, that it is difficult to believe the hypothesis well founded. Some of the most serious objections are ably presented by Whitman in an article accidentally published in the same number (p. 376), and arguing in favor of the annelidan affinities of vertebrates.] — (*Quart. journ. micr. sc.*, xxiii. 349.) C. S. M. [348

Embryology of Planaria polychroa. — Metschnikoff has studied the development of fresh-water planarians, and reached conclusions that are, in part, very startling. Pl. polychroa lays its egg-capsules in late spring and early summer. Each capsule contains from four to six eggs, and thousands of the so-called 'yolk-cells.' The egg has no membrane. The yolk-cells immediately around each ovum break down, their membranes disappear; but their nuclei remain for a long time distinguishable, although they finally disappear in the embryo, into the composition of which these disintegrated cells enter. The ovum segments, but the cleavage-cells do not cohere, there being no vitelline membrane: on the contrary, each embeds itself in the mass derived from the yolk-cells. In some manner, which is left in complete obscurity by the author's descriptions, the cells from the ovum gradually spread themselves, and form first the pharynx, and then an epidermal layer of thin cells, which encloses the whole of the disintegrated yolk-mass, together with cells from the ovum, embedded in it. In the centre of this mixed parenchym appears a cavity which communicates with the lumen of the pharynx. This last seizes and swallows the surrounding yolk-cells, each intact. The cells scattered through the body form the mesoderm (mesenchym), which arranges itself so as to form the partitions of the body, dividing the disintegrated yolk-mass into separate accumulations, which, combining with the yolk-cells swallowed, gradually assume the form of the intestine with its coeca. No entoderm exists, unless two cells at the base of the proboscis are a remnant of it. During these changes the nervous system appears, and the sheath around the proboscis is developed. Metschnikoff advances the opinion, that the yolk-cells swallowed, though not derived from the ovum, and being foreign bodies, nevertheless become the cells of the apparent entoderm of the adult. He further believes that the nervous system is derived from the mesoderm. If Metschnikoff is correct in maintaining, that, *first*, there are no epithelial germ-layers; *second*, the cleavage-cells are mixed with and embedded in a foreign substance; *third*, foreign cells form the entoderm, there being no embryonic entoderm; *fourth*, the nervous system is derived from the mesoderm, — then it is obvious that the general conclusions which we are wont to consider to have been well established by embryological research are erroneous, although they rest upon a vast body of evidence. One would suppose that no attempt to set this evidence aside would be made, except after the most unquestionable determination of new facts. Now, Metschnikoff's researches leave every one of the processes involved in his novel views in absolute darkness; for he has not, for the most part, observed them at all. His surprising deductions are based upon a failure to ascertain what are the actual processes, and seem to the reporter invalid. The value of the real observations is, of course, unaffected by the speculative portions of the essay. — (*Zeitsch. wiss. zool.*, xxxviii. 331.) C. S. M. [349

Insects.

Epidermal glands of caterpillars and Malachius. — The following are the principal results obtained by Stan. Klemensiewicz. 1°. The eighth and ninth segments of the larvae of Liparis, Leucoma, Orgyia, and Porthesia auriflua, have each a little protuberance on the median dorsal line, with the opening of a gland at the summit. The secretion is clear and odorless. The skin is invaginated at the top of the papilla to form a pendent sack, at the base of which are inserted two muscles running obliquely backwards; and there also open two glands by a common duct. The external surface of the glands is smooth, but in their interior each gland-cell forms a separate bulging mass: the appearance thus presented is singular. The lumen of the duct is very small; its thick walls are formed by two large cells, much like those of the gland proper. In Leucoma salicis there are quite similar glands on the fourth and fifth segments. 2°. The exsertile horns of Papilio Machaon, larva, are described. They are really developments of the tegument: the epidermal cells of their walls are large, and contain numerous rod-haped bodies; but the cells at the base of the horns are much smaller, and glandular (their secretion being probably discharged through pores of the adjacent cuticula). It may be assumed, that the odorous secretion accumulates in the invaginated horns, and is freed by their exsertion. 3°. The caterpillar of Harpyia vinula has a gland in the first segment, opening ventrally. The gland is flask-shaped, the neck acting as duct, and opening into a large transverse fissure; the body of the flask is the gland proper, and is lined by polygonal epithelial cells, with irregularly shaped nuclei; the epithelium rests upon a thin tunica propria. 4°. A similar organ to the last mentioned was described in Vanessa larvae, by Rogenhofer (*Verh. zool.-bot. ges. Wien*, xii. 1227): it is an invagination of the skin on the ventral side of the first segment; its cuticula is thin, and forms numerous little cups, under each of which is a thin epithelial cell. 5°. The orange-colored fleshy warts on the sides of the thorax and abdomen of Malachius are also glandular. The epidermis presents no special features in the warts, except that it bears scattered unicellular glands of the form typical for insects; they are flask-shaped, with a coiled cuticular duct in their interior, the duct being continuous with a pore-canal through the general cuticula of the wart. In the lower and larger end of each cell, lies the round nucleus. — (*Verh. zool.-bot. ges. Wien*, xxxii. 459.) C. S. M. [350

ANTHROPOLOGY.

Prehistoric copper. — Professor J. D. Butler confidently asserts that the Wisconsin state historical society's collection contains more American aboriginal copper implements than he has been able to hear of in all other cabinets whatever. One axe weighs four pounds twelve ounces and a quarter, and is the heaviest article of wrought copper as yet brought to light. Fourteen new implements have lately been added, some of them unique in form, or size, or in the location from which they were derived. More than fifty coppers have come to the cabinet from Washington county alone. This fact is doubtless due to Mr. Perkins's persistent search in that locality. — (*Wisc. hist. coll.*, ix. 97.) J. W. P. [351

Aztalan. — The largest and most elaborate aboriginal monument in Wisconsin is Aztalan, fifty miles east of Madison. It was first discovered by Timothy Johnson in 1836, and described by Nathaniel F. Hyer in the *Milwaukee advertiser*, January, 1837. Mr. Stephen Taylor gave an illustrated account of it in *Silliman's journal* in 1843; and the place was first accurately surveyed and plotted by Dr. Lapham, in 1850, whose description and drawings were published in 1855, in the Smithsonian contributions to knowledge. "This strange monument," says Prof. Butler, "was styled Aztalan by Mr. Hyer, inasmuch as it seemed to him a structure worthy of the Aztecs." Upon this point Mr. Peet says, "The name Aztalan was derived from a tradition, which was said to be common among the Indians, that a people partially civilized built here a city, and a hundred years afterward, becoming dissatisfied, proceeded south to Mexico." There is no reason to suppose that the Aztecs, or any other Mexican people, were in any way connected with it. Much curiosity has been excited with reference to the Aztalan bricks, which are shapeless clods of clay, burnt red and pretty hard. The process of burning is supposed to have been similar to that discovered by Schliemann at Troy. The soil, a sort of loam, had been thrown up into a rampart, the whole coated with clay matted together with bushes and sedge. Over all were heaped prairie-grass and trees, and the pile set on fire. Dr. Yarrow describes a like process pursued in North Carolina grave-mounds. — (*Wisc. hist. coll.*, ix. 99.) J. W. P. [352

EARLY INSTITUTIONS.

History of agricultural prices in England. — M. Jusserand reviews Mr. Thorold Rogers's work upon this subject. He pronounces it one of the great books of our century, and indispensable to the student of economic history. It is full of facts hitherto unknown, or, if known, unclassified, and inaccessible to most students. Mr. Rogers's opinion that the fifteenth century, and the beginning of the sixteenth, was a golden age for the laboring-people of England, is cited as especially notable, inasmuch as a contrary opinion has generally obtained up to this time. — (*Rev. critique*, 18 juin, 1883.) D. W. R. [353

Indirect taxation among the Romans. — M. Dareste sums up all, or nearly all, that is known upon this subject. Very little is known; and very little is likely to be known, unless some more inscriptions, like that discovered not long ago in the ruins of Palmyra, should be found. It was an important find, — a custom-house tariff with regulations regarding the collection of duties. (See *Bull. corresp. hellén.*, mai–juin, 1882.) The inscription has not yet been published. The principal indirect taxes of the Romans were, the custom-house duty (portorium), a tax on successions, upon the manumission of slaves, and the sale of movable goods. They were not very heavy taxes at any time. M. Dareste gives us a very good account of the portorium. The Roman custom-houses were scattered about here and there, wherever merchants were wont to pass or to congregate. A list of localities where there were custom-houses is given. The portorium was a percentage levied upon the value of merchandise. Only merchandise was subject to it. Personal effects of travellers, *instrumenta itineris*, etc., were free of duty. A list of writings upon the subject is given. The principal work cited is that of M. R. Cagnat: *Étude historique sur les impôts indirects chez les Romains.* It was written before the discovery of the Palmyra inscription. — (*Séances trav. acad. inscr.*, Feb.–March, 1883.) D. W. R. [354

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Field-work of the division of the Great Basin. — In consequence of the extension of the work of the survey to the Atlantic states, the director has found it necessary to divert some of its force from investigations already initiated. One of the most important researches thus stopped is that of the quaternary lakes of the Great Basin. The corps was reduced at the beginning of the fiscal year, and instructed to devote the field season to supplementing the material already acquired, so as to prepare it for publication without future visits to the district.

The office at Salt-Lake City was closed on the 30th of June, and field operations were immediately begun. Mr. I. C. Russell, assistant geologist, proceeded to Mono valley, California, and carried to completion his examination of the existing lake and its ancient expansion. He included in his study, also, the six extinct glaciers which anciently debouched in the Mono valley, tracing them to their common source in the great névé of the Sierra Nevada. Incidentally he examined the ice-masses associated with some of the summits of the Sierra, and brought the camera to bear on them. These have been called glaciers by Muir and others, but are said by King to be unworthy of the name; and it may be hoped that these later observations and illustrations will suffice to place the matter beyond controversy.

From the Mono basin he proceeded to the Walker, Carson, Pyramid, Winnemucca, and Black Rock basins, for the purpose of re-investigating certain points connected with the history of the ancient Lake Lahontan, upon which he is preparing a report.

Mr. W. D. Johnson, topographer of the division, spent the summer, under Mr. Russell's direction, in surveys for a general map of the Mono basin, and is now engaged on a series of special maps of ancient glacial moraines.

Ensign J. B. Bernadou, detailed from the navy for the purpose, has acted during the summer as Mr. Russell's assistant.

Mr. G. K. Gilbert, who has general charge of the work, spent a few weeks in the field, visiting localities of special interest in the Lahontan, Bonneville, and Mono basins. He was accompanied in the Lahontan basin by Mr. R. Ellsworth Call, the conchologist, who is engaged in a study of the molluscan faunas of the quaternary lakes of the Great Basin, and took the field for the purpose of familiarizing himself with their geological relations.

The Champlain valley. — Mr. Charles D. Walcott, with Mr. C. Curtice as assistant, has been studying the formations between the archean and Trenton in Saratoga county, N.Y., and along up the Champlain valley on both sides of the lake.

Saratoga village, west of the fault-line along which the springs occur, was found to be built over a massive, gray, magnesian limestone, that carries a strongly marked fauna closely allied to that of the Potsdam sandstone of Wisconsin. The geologic section from the archean to the base of the bird's-eye limestone was found to be of great interest. At Glen Falls, Essex, Ausable Chasm, and Chazy, N.Y., sections were taken, and collections formed.

The sections taken at Highgate Springs, Swanton, St. Alban's, and Georgia, Vt., by Professor Jules Marcou, were critically examined, and large collections of fossils secured. The data obtained show the dip of the Winooski marble series and the slates above, carrying the Olenellus fauna, to be the same. The five hundred feet of magnesian limestone, with its interbedded arenaceous layers, conformably underlie the Olenellus beds. The fauna at the Georgia locality was increased by the addition of eight species not before reported as occurring there.

NOTES AND NEWS.

Mr. H. M. Stanley contributes to the *New-Englander* an interesting, and, on the whole, clearly written study, entitled 'Evolution as bearing on method in teleology.' The essay follows a train of thought somewhat similar to the one stated in a book that appears almost at the same time, and that we reviewed recently; viz., Mr. Hicks's Critique of design arguments. Mr. Stanley is thankful to the doctrine of evolution for having rid teleology of a useless and somewhat dangerous argument, — the argument from mere ignorance; i.e., from our incapacity to explain certain singular or wonderful things save by supposing a powerful being directly working to produce them. This argument, which covers, on the whole, much the same ground as is covered by what Mr. Hicks calls teleology in the narrower sense, is regarded by Mr. Stanley as superseded by the doctrine of evolution. We now see that nature ought to be regarded as a 'practically infinite series of second causes;' so that, if we are now ignorant of the cause of any phenomenon, we still have a right to expect to find for it hereafter a purely natural cause. Every thing has grown; and we have to view nature as a vast and perfect machine, self-supplying, self-regulating, and not needing any workman to stand by to watch the steam-gauge, to put in the material, or to oil the bearings. Yet this view is not atheistic, according to Mr. Stanley; for the supposition of a designing intelligence remains, only this intelligence is 'immanently behind phenomena.' By this being, all things consist. In fact, the more nearly automatic the machine, the more perfect the contriving intelligence. "If an automatic locomotive-machine is a sign of very great intelligence, how much greater intelligence would an automatic universe-machine exhibit? . . . Teleology has been called a 'carpenter theory,' but a teleology which views the universe as a practically infinite automatic machine would forever destroy the force of any such epithet." In other words, as we understand Mr. Stanley, a 'practically infinite' carpenter would be something much better than a carpenter; and teleology gains rather than loses when the doctrine of evolution shows that the carpenter's tinkering of his work, if there is any tinkering, is practically infinitesimal. All this seems to us not at all novel; but, for the most part, it is very well put, and worth saying.

But when we inquire of any of these evolutionary design arguments, not how they defend themselves against the charge of atheism, but how they demonstrate theism, we are disappointed. Mr. Hicks, as we saw in reviewing him, is very definite on this point as to what he attempts, and as to what he does not attempt; but his definiteness only serves to show his weakness. He declares that order, as such, is proof of intelligence, but adds that the proof is solely inductive. Men are orderly because they are intelligent: hence nature, if orderly, must be somehow associated with intelligence. We answered this induction by asking whether all brilliantly colored objects must needs be visited by insects merely because the colors of flowers depend upon *their* relations to the habits of insects. But with Mr. Stanley we hardly have room for so definite a criticism; for, though his argument in favor of theism, in so far as he suggests one at all, seems to be inductive, it seems also most carefully to shun any such definite statement as should make it definitely answerable. The vast machine needs, it would seem, a controlling intelligence, which does not interfere with it, and yet does somehow direct it. The 'practically infinite series of second causes' is not enough by itself, and we must somehow get outside of it to find a designer; and, when we ask how the designer is related to the series of second causes, we get the charmingly innocent answer, that he is 'immanently behind phenomena,' — an expression that seems to us either mere words, or else an excellent Irish bull. Perhaps Mr. Stanley can explain this phrase for us; but meanwhile, as one casts about for an interpretation, one is reminded strongly of Brer Fox, in the wonderful tar-baby story, as he 'lay low' in the bushes, watching his creation the tar-baby while it slowly intrapped Brer Rabbit. Possibly Brer Fox was 'immanently behind' that tar-baby. But our criticism is only of bad arguments and of obscure expressions, not of the view itself that the order of the universe implies an intelligence. The latter we hold as positively as Mr. Hicks or Mr. Stanley, only we insist that the question is not in the least one of inductive science. The 'design' argument in all its accustomed forms is bad, because it is an inductive argument, applied as true empirical science never applies any inductive arguments; viz., to matters wholly beyond the limits of phenomenal existence. The whole question is one of philosophy. Not as a result of induction, but as an implied premise of the inductive, or of some other rational thinking process, must this doctrine of intelligence in nature be established, if at all; and therefore only a critical philosophy, that examines the assumptions lying at the basis of the thinking processes, has any business with the question. Empirical science, as such, has simply once for all 'no need of that hypothesis.'

— A fire broke out last week in the cellar of the building containing the geological collections at Amherst college. Fortunately it was discovered early, and put out by the students before any serious damage was done. It will be recollected that the college lost the fine mineralogical cabinet of Prof. C. M. Shepard last year by fire; and the fear of a repetition of that disaster caused a too hasty removal of many objects from the lower floor, labels and specimens becoming sadly mixed. The wind was very high; and, had the fire gained greater headway, nothing could have saved the museum, or the observatory attached.

— Charles Leslie McKay of the U.S. signal-service, stationed at Nushegak, Alaska, was drowned in Bristol Bay last April, while engaged in collecting fishes for the U.S. national museum. Mr. McKay had done considerable work in ichthyology, his most important publication being a 'Review of the Centrarchidae,' in the Proceedings of the U. S. national museum for 1881.

— At its meeting, Oct. 27, the Philosophical society of Washington listened to a communication by Dr. T. N. Gill on the ichthyological results of the voyage of the Albatross, and to one by Prof. A. Graham Bell on fallacies concerning the deaf. Dr. Gill described two anomalous fishes, one of which required the institution of a new order. Professor Bell's paper was the subject of a lively debate.

— Those who have followed the discussions in Science on the St. David's rocks will be interested in a new phase of the controversy, introduced by a paper before the British association by Prof. J. F. Blake. The rocks below the Cambrian conglomerate have been described by Dr. Hicks as bedded rocks belonging to three distinct periods. The same rocks have been recently asserted by Dr. Geikie to be partly Cambrian, and partly intrusive. Professor Blake contends that they are pre-Cambrian in age, but form a very complete volcanic series, which may well be designated the Dimetian. The basis of the series is the Dimetian granite, serving as the core. This is surrounded by the more acid rocks, as the quartz felsites and the felspar porphyries (the so-called Arvonian); and the more outlying portions consist of very varying materials, chiefly rough ashes or agglomerate breccias, — on the east side finely-bedded 'halleflintas,' and on the north side many basic lava-flows. These are the so-called 'Pebidian.' The arrangement of these rocks shows the characteristic irregularity of volcanic rocks; and, though many portions are bedded, they have no dominant strike over the whole district. The Cambrian series, commencing with the conglomerates, is quite independent, and hangs together as a whole. In no case can a continuous passage be proved from the one series to the other: the junction is in most cases a faulted one; and, at the places where this is not so, the conglomerate lies on different beds of the volcanic series.

—At the meeting of the Boston society of natural history, Nov. 7, Prof. H. W. Haynes spoke of the agricultural implements of the New-England Indians, Prof. W. O. Crosby read a paper on the origin and relations of continents and ocean-basins, and Dr. M. E. Wadsworth gave brief notes on the lithology of the island of Jura, Scotland.

— Mr. George Shoemaker, a very industrious and promising young naturalist connected with the National museum, died in Washington on the 12th of October.

— Herr Jacobson, who has spent four years on the north-west coast of America in making ethnological collections for the Berlin museum, has recently returned, and will sail for Europe.

— Dr. Leonhard Stejneger has arrived in San Francisco, *en route* for Washington. He has spent a year in Bering Island in the study of its fauna, and in collecting remains of the extinct arctic sea-cow.

— The Hydrographic office has published a monograph (no. 4.), by Lieut. Southerland, upon the two August hurricanes. It contains abstracts from the logs of forty vessels which were near the path of one or both of these storms, a chart of the course of each storm, a diagram of the tracks of two barques which were near the path of the second hurricane, and sailing-directions for managing vessels when near similar dangerous cyclones. The projected paths resemble those previously published by the signal-office in the Weather review for August (Science, no. 37), but differ somewhat in detail. The latter were based upon the reports of more vessels than those enumerated by Lieut. Southerland. Some of the ships mentioned are common to the two reports; but doubtless a more accurate representation of the paths of the hurricanes could have been obtained, had all the data been combined in one report.

— Mr. J. B. Fell, C E., gave a paper on the construction and working of alpine railways, at the recent meeting of the British association, which is thus reported in *Nature*. There are three alpine railways in existence at the present time, — the Mont Cenis and St. Gothard railways, which have been made with long summit tunnels, and with ordinary gradients; and the Brenner railway, that has been made with similar gradients, but without a long tunnel. The important question has now arisen, and has been taken into serious consideration by the governments and local authorities interested, as to how far it may be possible to make other trans-alpine railways, some of which are urgently needed, at a cost that would render them financially practicable; and, to accomplish this object, it has been proposed to effect a reduction of one-half or more of the cost, by carrying these railways over the mountain-passes by means of steep gradients and the use of the centre rail system, as it was adopted on the Mont Cenis railway. Upon these improved summit railways the same weight and number of trains could be run that are now running on the Mont Cenis tunnel railway; and, with the protection of avalanche galleries and covered ways, the regularity of the service would be maintained at all seasons of the year. The extra cost of working-expenses caused by working over a higher level than that of a tunnel line would, if capitalized and added to the cost of construction, still leave a clear net saving of more than one-half in the cost of construction, as compared with the cost of a tunnel railway. The result of the experiences of the last twenty-five years seems to point to the conclusion that a method of constructing alpine railways with long, non-paying tunnels, is a thing of the past. The future belongs to the best system that can be devised for overcoming the difficulties of trans-alpine railways rather by adding to the powers of the locomotive-engine, and by other mechanical appliances for reducing the cost of traction on steep inclines, which methods are capable of indefinite improvement, than by burying in gigantic tunnels enormous sums of unproductive capital, that, when once expended, are irrecoverably lost.

— We learn from *Nature* that the electric railway from Portrush to the Giant's Causeway was opened Sept. 28 by Earl Spencer; and among others present, were Sir William Thomson, Sir William Siemens, and Sir Frederick Bramwell. It is over six miles long, and has cost £45,000. The line, after passing through the principal street of Portrush, follows the seaside road, a portion of a footpath six feet broad being reserved for the railway. The gauge is only three feet; and the gradients are very steep, — in places as much as one in thirty-five; and in parts of its course the curves are sharper than might have been desirable had the route which it takes been chosen by the engineers. The force to work it is generated by a waterfall in the river Bush, with an available head of twenty-four feet, the electric current being conveyed by an underground cable to the end of the tramway. The water-power passing through turbine water-wheels, which utilize the whole force of the fall, is said to amount to ninety horse.

— At the meeting of the Engineers' club of Philadelphia, Oct. 20, Mr. John Haug exhibited and described very complete sets of drawings for two vessels designed by him, — the one a tug-boat for the Philadelphia board of health, and the other a barge for the transportation of freight and passenger cars. Mr. J. H. Harden read a paper, prepared for publication as part of the Report of the second geological survey of Pennsylvania, relating to the "Early mining operations in Berks and Chester counties, including the present condition of the Jones mine." Prof. L. M. Haupt presented notes on conventional colors for drawing.

— Before the Biological society of Washington, at its meeting, Nov. 2, the communications were: Dr. George M. Sternberg, U.S.A., Micrococci; Dr. E. M. Schaeffer, Further remarks on manna, with exhibition of specimens; Dr. T. H. Bean, Arrested asymmetry in a flounder, with exhibition of specimens; Professor Lester F. Ward, Mesozoic dicotyledons.

— The autumn meeting of the Society of mechanical engineers, which has just closed in New York, has been unusually well attended, and some important lines of discussion have been drawn out. Considerable interest was shown in the proposed re-appointment of a board to supervise the work with the Watertown testing-machine.

— The Massachusetts agricultural experiment-station at the Agricultural college in Amherst, Mass., was established by an act of the legislature approved on the 12th of May, 1882. Its management is vested in a board of control, consisting of the governor of the state, two members of the state board of agriculture, two members of the board of trustees of the Massachusetts agricultural college, one member of the Massachusetts society for promoting agriculture, and the president of the Massachusetts agricultural college. The present officers of the station are all members of the college faculty, and are Prof. C. A. Goessmann, director and chemist; Prof. M. Miles, superintendent of field and stock experiments; and Prof. S. T. Maynard, superintendent of horticultural experiments, microscopist, and draughtsman. The station proposes to publish monthly bulletins, of which two have already appeared. The first contains an account of the organization of the station, and a general statement of its purposes, and also analyses of ten samples of fodders. The second and third bulletins contain analyses of four samples of fodders and of fifty-six of fertilizers and fertilizing materials.

— An extended review of the results of the German census of 1881 is given by Ch. Grad in the *Revue scientifique*, 1883, 109.

RECENT BOOKS AND PAMPHLETS.

Bachmann, O. Unsere modernen mikroskope und deren sämmtliche hilfs- und neben-apparate für wissenschaftliche forschungen. München, *Oldenburg*, 1883. 15+344 p., illustr. 8°.

Burr, W. H. The elasticity and resistance of the materials of engineering. New York, *Wiley*, 1883. 15+753 p. 8°.

Campagne, E. Les météores. Rouen, *Mégard*, 1883. 189 p., illustr. 8°.

Denza, F. La meteorologia e le sue più recenti applicazioni. Torino, *Speirani*, 1883. 364 p. 8°.

Fallet, C. Les mers polaires. Rouen, *Mégard*, 1883. 160 p., illustr. 8°.

Gérardin, L. Les bêtes, éléments de zoologie théorique et appliquée. Paris, *Masson*, 1883. 2+418 p., illustr. 18°.

Landolt, H., and **Börnstein**, R. Physikalisch-chemische tabellen. Berlin, *Springer*, 1883. 12+249 p. 8°.

MacCord, C. W. Kinematics: a treatise on the modification of motion, as affected by the forms and modes of connection of the moving parts of machines; illustrated by diagrams of mechanical movements, as practically constructed; for the use of draughtsmen, machinists, and students of mechanical engineering. New York, *Wiley*, 1883. 9+335 p. 8°.

Malte-Brun. Lectures géographiques: l'Europe, description générale. Limoges, *Barbou*, 1883. 141 p. 12°.

Ollivier-Beauregard. En Asie, Kachmir et Tibet, étude d'ethnographie ancienne et moderne. Paris, *Maisonneuve*, 1883. 144 p. 8°.

Petit, H. Notes sur l'habitat des coléoptères de France. Châlons-sur-Marne, *Martin*, 1883. 66 p. 8°.

Physik, die, im dienste der wissenschaft, der kunst und des praktischen lebens. Red. G. Krebs, unter mitwirkung von J. van Bebber, C. Grahwinkel, E. Hartwig. lief. i. Stuttgart, *Enke*, 1883. 112 p., illustr. 8°.

Reusch, H. H. Die fossilien führenden krystallinischen schiefer von Bergen in Norwegen. Autorisirte deutsche ausgabe von R. Baldauf. Leipzig, *Engelmann*, 1883. 4+134 p., 92 illustr., map. 8°.

Trautvetter, E. R. Incrementa florae phaenogamae rossicae. fasc. i. Berlin, *Friedländer*, 1882. 4+240 p. 8°.

Tschermak, G. Die mikroskopische beschaffenheit der meteoriten, erläutert durch photographische abbildungen. lief. i. Stuttgart, *Schweizerbart*, 1883. 12 p., 8 pl. 4°.

Van Overbeck de Meijer. Les systèmes d'évacuation des eaux et immondices d'une ville. Paris, *Baillière*, 1883. 143 p. 8°.

Weismann, A. Ueber die ewigkeit des lebens. Freiburg-i.-Br., *Mohr*, 1883. 79 p. 4°.

Weselsky, P., and **Benedikt**, R. Dreizig uebungs-aufgaben als erste anleitung zur quantitativen analyse. Wien, *Treflitz & Deuticke*, 1883. 41 p., illustr. 8°.

Weyr, E. Die elemente der projectivischen geometrie. heft i.: Theorie der projectivischen grundgebilde erster stufe und der quadratischen involutionen. Wien, *Braumüller*, 1883. 9+231 p. 8°.

Witthaus, R. A. The medical student's manual of chemistry. New York, *Wood*, 1883. 370 p., illustr. 8°.

Wright, E. P. Animal life: being the natural history of animals. New York, *Cassell*, [1883.] 8+618 p., illustr. 8°.

SCIENCE.

FRIDAY, NOVEMBER 16, 1883.

FROM SUPERSTITION TO HUMBUG.

It is related that especially fortunate English commanders in India have encountered a tendency among the ignorant natives to exalt them as more than human beings. It is not strange that a benighted and superstitious populace, astonished by exhibitions of power to it incomprehensible, should, for a time, turn from its own hazy gods to new and visible wonder-workers.

A somewhat similar revolution appears to accompany the progress of physical science. What its friends have to contend with at present is not so much indifference or hostility, though these are not altogether lacking, as a too implicit and childlike confidence in the efficiency of scientific knowledge on the part of those to whom its ways are in the main unknown.

The real conquests of science have been so vast and unexpected, so much like the workings of magic, that people eagerly pay their homage to a power, which, though mysterious enough to engage their credulity, accomplishes every day feats that witches, ghosts, and magicians performed only upon rare occasions. A genuine scientific man will disdain to abuse this confidence; but there are always camp-followers of the scientific army, who will find in it their opportunity. It is curious to see how those, who, a generation or two ago, would have been the believers in witchcraft and all things 'supernatural,' are now turning to be caught in the toils of scientific charlatanry. The wizard of the present day is an electrician. Electricity and magnetism have become literally words to conjure with.

There is a certain progress in this, though not in itself a valuable progress. It is the advance from sheer ignorance to that little knowledge which is proverbially a dangerous thing. It is the advance from pure superstition, in which men did not reason at all, to humbug, in which they reason from false or insufficient premises to wrong conclusions.

It should be said in justice to the scientific charlatan, that he is frequently not dangerous, and is nearly always amusing. He possesses an audacity, a volubility, that, combined with his habit of blundering, make him a far more cheerful person to contemplate than his gloomy predecessor, the sorcerer. Take, for instance, the modern master of that ancient black art of divination by rods. A newspaper report makes a 'professor' of the science of 'magnetic geology,' as he calls it, speak as follows: —

> "You take the ends of the forks, and grasp them tightly in either hand, allowing that portion where the forks join to point upward. . . . When one walks over a mineral substance in the ground, the electricity ascends through the body into the hands and rod, and draws the central or connecting portion of the rod downward. When this occurs, minerals exist beneath the spot where you stand. If the rod begins to move as the person walks along, take particular notice of the spot where you stand when the movement begins. When the rod turns completely over, measure the distance from where it first began to move to the spot where it indicates minerals. This distance will give you the depth at which the mineral can be found."

'Rabdomancy, or divination by rods, is as old as history,' some one recently remarked. The feature of this science peculiar to our age is the pretence of explaining it. That the method is still resorted to quite widely, there can be no doubt. We read in a Vermont paper, that a few months ago the public authorities of Middlebury resorted to the rod when about to sink an artesian well. They then sank a shaft eighty feet at the spot designated, and there struck, not water, but flint. We have lately heard of a man who ascertains by the divining-rod the proper spot for grounding lightning-rods. We have never seen a statement of his theory in his own words; but it appears that he holds the doctrine that atmospheric electricity follows, or is controlled by, the course of underground electric currents. He claims, moreover, to be endowed with a peculiar sensitiveness that enables him, by walking over the ground with the forked stick in his hands, to detect the location of these currents. The last touch is given to this theory by the statement that it is necessary for the gifted manipulator of the rod to wear rubber boots during the operation of divining, in order that he may be insulated from the ground.

In regard to the human body and the remedies for its ills, people have always been superstitious; and so, naturally enough, the number of 'electric' and 'magnetic' nostrums offered to afflicted humanity is very great. Their descriptions, however, are nearly always worth reading. Custom cannot stale the infinite variety of their absurdities. Here is a specimen which came to hand a few days since in the advertising columns of a college paper: —

"Labor, study, and research in America, Europe, and Eastern lands, have resulted in the Magnetic Lung Protector, . . . which, . . . with the continuous stream of magnetism permeating through the afflicted organs, must restore them to a healthy action."

There is a class of people who call themselves magnetic physicians, — people who cure, in a modern way, by the laying-on of hands. They are apparently closely allied to the spiritualistic mediums, and evidently intend to use something more than a figure of speech in calling themselves magnetic. There is, for instance, in or near San Francisco, a certain Dr. H——, who gives people what he calls magnetic baths. He claims to magnetize the water for the baths by dipping his hand in it. He is said to have an extensive practice. We have heard that the notorious Slade, whose feats made such an impression upon Professor Zöllner, claimed to possess a literal magnetic power, enabling him to rotate the plane of polarization of light.

Whatever may be the case with these peculiar people, it appears that others, not especially superstitious, do believe themselves particularly endowed or charged with electricity, because, for instance, they succeed in drawing sparks from their hair or clothing during cold weather. Of course, some people do have drier hair, or drier skins, than others, and do, therefore, as frictional electrical machines, surpass the majority of their fellow-mortals. Moreover, physiologists believe that in living bodies there exist slight electric currents capable of being detected by very sensitive apparatus. But apparently it is not with any intelligent reference to these exceedingly minute currents, or to an electric charge acquired by friction, that a man speaks, when he offers to rub a weak or disabled arm because he is 'strong, and full of electricity, you know.' The fact is, we do not know, and we wish the man would explain.

It would appear that such terms as 'animal magnetism,' and 'personal magnetism,' originating, no doubt, in metaphor, are sometimes taken almost literally. We have met one or two very intelligent people who seemed to have a vague idea that psychological problems might be attacked by means of the laws of electricity and magnetism.

This list of frauds and delusions might be greatly extended. Enough has been said, however, to illustrate some of the kinds of error into which people are led by their ignorance of the results and methods of scientific research. The need of a wider and more intimate knowledge of physics in the education of all classes would, no doubt, be generally acknowledged. It should be observed, however, that the kind of half-knowledge of this subject which is frequently obtained from newspapers, and even from public lectures and popular scientific books, is the very pabulum of such errors and humbugs as we have described. A woman hears a lecture on sympathetic vibrations, fundamental tones, etc., notes the trembling of a church under the music of the organ, and writes to her religious paper an enthusiastic letter explaining the fall of Jericho in a scientific manner, — and all in the interests of revealed religion.

A man reads, or sees in a public hall, that two electrified pith-balls attract or repel each other. He learns that the human body may be charged with electricity. Straightway he begins, upon this basis, to explain the table-tipping feats of spiritualistic mediums, — a gross error, hardly more respectable than the pure superstitition of the veriest believer in ghosts.

To make such errors impossible would require that definite, familiar knowledge of things, in their quantitative relations, which is hardly to be obtained without actual contact. It would require a laboratory training; and it is perhaps impossible to make provision for a very extended training of this sort in any scheme of general education.

The tendency of the times, however, is toward the objective and experimental in teaching; and it is probable that the next few years will see considerable changes in the methods of general instruction in physics.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — III.

We may now pass on from the small day-time whirls of dry air to the larger, long-enduring storms that are accompanied by rain; and here will be met two new elements, — the effect of condensing vapor, and the effect of the earth's rotation, — both of great importance. As a sample under this second heading, we may take one of the cyclones of the Bay of Bengal; for the storms there are very characteristic of their class, and have of late years received much careful attention. There is good reason for thinking that these cyclones generally spring up in calms, much as the desert-whirls begin. The seasons and regions of their occurrence both point to that conclusion; for tropical cyclones seem never to begin in well-established wind-currents, but rather in a place of quiet, weak, or variable winds. By India, for example, the cyclones are almost unknown during the prevalence of the steady blowing monsoons, but are not uncommon at those seasons when the monsoons change: that is, at times when the air has no well-established motion, but stands about idly, waiting for a decisive command to move on. During these idle times of stagnation, the lower air may become very warm and moist, and so prepare for a stormy overturning. The calm that precedes a cyclone often makes part of the description of a storm at sea: the air is close and oppressively warm; the water settles down to a glassy surface; and now we may see, what is not always clearly expressed, that this calmness of the water, and oppressive heat of the air, are not antecedent effects of the coming storm, but are actually the conditions that allow and determine the beginning of a storm. The warmer the air and the quieter the water, the longer must have been the preparatory stage; the greater the quantity of solar force collected in the lower atmosphere, the more violent will be the storm when it begins. This warm calm is really the embryo of the cyclone; and, if it lie long enough in a proper latitude, it will grow to well-developed maturity.

It is often stated that tropical oceanic cyclones begin at the meeting of two opposite currents of air rather than at a time of calm. This may be true for some cases, and undoubtedly has a very general application in temperate latitudes; but it seems more probable that in the Bengal cyclones, and most other tropical hurricanes, this stage is a little later than the earliest beginning, and is really the first development of the inblowing winds. A general calm would doubtless be found to precede such opposed currents if observation could trace the antecedent conditions a little farther back than is usually possible. The principal contrasts between the desert-whirls and the Bengal cyclones, at the time of their beginning, may be thus summarized: —

First, The area and uniformity of the surface on which the disturbance is developed is much greater on the ocean than on the desert.

Second, There is a lower temperature, but a much greater amount of heat, surface for surface, in the cyclone's embryo, than in the whirlwind's. The temperature of the air over the ocean seldom exceeds 95°: over the desert sands it may often rise to 140° or 150° close to the ground. But on the desert the stratum of air that is so excessively warmed is very thin; it often fails to reach the height of a man's eye, and so gives the appearance of a mirage: while over the sea, although the lower stratum is not so warm, its thickness is greater, and there is more of it warmed. What it lacks in temperature it more than makes up in quantity.

Third. The presence of water-vapor over the ocean makes a most important contrast between the two cases; and it is on this account that the warm sea-air is cooler than the hot desert-

[1] Continued from No. 40.

air. Water-vapor is not nearly so diathermous as dry air. Much of the heat that would pass down to the sand on the desert is held back by the vapor over the ocean, and some is caught again from the heat radiated upwards by the water, so that a considerable thickness of air is warmed. Of still more importance is the vapor's action as a great storehouse of solar force, required in the process of its evaporation, generally known as 'latent heat.' For all these reasons, the accumulation of energy in the preparation for an oceanic cyclone is vastly greater than in the making ready for a desert-whirl.

(*To be continued.*)

REMARKS UPON THE OSTEOLOGY OF PHALACROCORAX BICRISTATUS

It is a fortunate thing for science, that time allowed many of our Alaskan explorers to bring back in their collections, and to the museums, skeletons of so many of the rarer forms of the vertebrates, particularly the birds of those unfrequented regions. To Dr. T. H. Bean and Mr. H. W. Elliott, both of the Smithsonian institution, we are under lasting obligations for such material, and for making so good use of their advantages. The writer has enjoyed the unusual privilege of examining and studying long series of skeletons of Lobipes hyperboreus, Haematopus niger, rare forms of Rissa, Larus, and Sterna, many of the auks, puffins, and the like, — nearly all from the source that I have mentioned.

It was during the course of my examination of these sub-arctic rarities that my attention was called to several points of interest in a set of skeletons, representing three young and an old one, of a species of cormorant, Phalacrocorax bicristatus, forming part of the collection of the last-named naturalist. Professor Owen, in the second volume of his 'Comparative anatomy and physiology of vertebrates,' on p. 64, speaks of a bony style that is attached to the occiput in the cormorant as one of the cranial peculiarities of the class. This author does not mention its use; and as the writer has not a cormorant before him intact, with all the soft parts, it would be hardly safe to give its exact function in this bird's economy: but as I do not believe we have a figure showing the site of this bonelet, an illustration of the skull of Phalacrocorax is here given, showing, life-size, the right lateral view. This prominent style is seen protruding from the summit of the occiput in my drawing, not as a spinous outgrowth from that point, but rather as a free bone, concave below, separated into two concavities on its superior aspect by a sharp median crest that is developed on its entire length, — a transverse elliptical facet anteriorly, that articulates freely with a corresponding one on the occiput.

At the base of the cranium, we find that the pterygoids are completely overshadowed by the sub-compressed but rather large brain-case above. There are no basi-sphenoidal processes thrown out to meet these bones. The posterior halves of the palatines form a close union all along their median and inner margins, which portions are much spread out horizontally. Beyond, they become narrower; and in the space that we find existing between them we observe a long attenuated vomer, terminating anteriorly in a free, pointed extremity. The cormorants belong to the Dysporomorphae of Professor Huxley's classification; and he and other eminent anatomists have given other cranial characteristics in their descriptions of this well-defined group. The rami of the lower mandible are deeply grooved on the inner aspects of the dentary portion; and these elements, originally free, retain their sutures, distinctly marked, through life, where they join the other interested segments at the posterior moiety. Seventeen vertebrae are found in the cervical region, before we arrive at one that bears a free pair of ribs. Of this

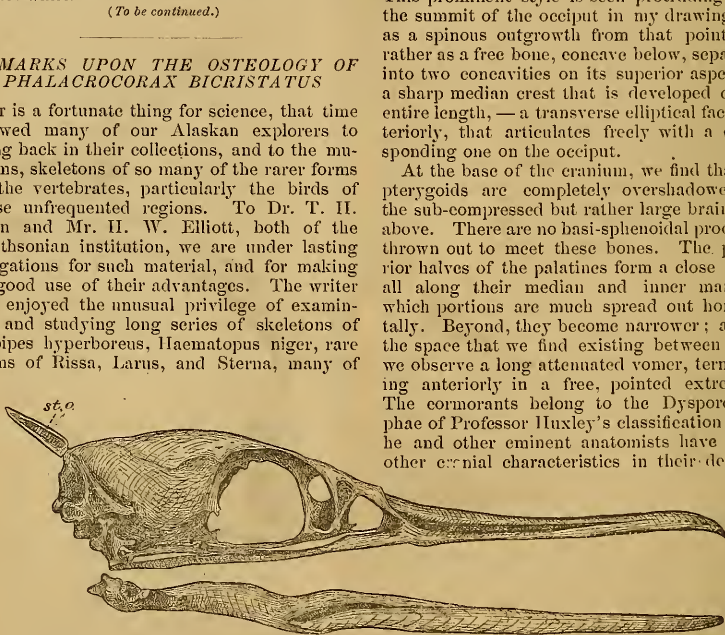


Fig. 1. — Skull of Phalacrocorax bicristatus, life size; right lateral view, showing occipital style, *st. o.*

series, we find the atlas and axis articulating in the usual manner, the former with its cup-like depression with the occipital condyle, the vertebra being perforated at its base. The parial parapophyses beneath the centra of these vertebrae are more or less prominent throughout; but in the eighth, ninth, and tenth, they are developed to an unusual extent, being long, needle-like processes, reaching nearly the entire length of the vertebra. A small pair of rudimentary free ribs are found beneath the transverse processes of the eighteenth vertebra. The next two ensuing ones have their ribs well developed, and bear large uncinate processes; but their lower ends still fail to be connected with the sternum by the intervention of costal ribs. Three more dorsal vertebrae are found before we come to the anchylosed series of the sacrum. These all have true ribs connected with the sternum by costal ribs, and their uncinate processes are strongly produced. A pair of ribs, as well developed in every particular as the series just mentioned, springs from beneath the ilium on either side, joining costal ones below; but the last pair of all, or the second that is produced from the anchylosed vertebrae of the sacrum, is without the uncinate processes, and in the specimen before us the costal rib on the left side is the only one of this pair that meets the sternum in a true facet. On the opposite side it articulates along the posterior border of the haemapophysis beyond it. The neural spines completely coalesce, in the ultimate sacral vertebrae, into a well-pronounced crest, which is surmounted along its entire length with a spreading cap of bone.

There are six free caudal vertebrae, not including the terminal segment or pygostyle, here quite large, pointed above, and possessing a moderately dilated posterior margin, thrown out to support the rectrices of the tail. The two anterior free caudal vertebrae are quite firmly grasped on either side by characteristic spine-like processes thrown backward, and developed on the part of the ilia. A lateral view of the pelvis, which is very long and much compressed from side to side, shows the ischiadic foramen to be an unusually large aperture, while the slender pubic bone fails to close in the other two foramina below, that are found in many other birds. This last-mentioned element of the pelvis slightly expands behind, where it meets the lower margin of the ischium for about a centimetre of its length. It then contracts again in size a little, to be directed downwards, and curved inwards. The body of the sternum is quadrilateral in outline, with two rather shallow excavations on either side of the median line, occupying the entire xiphoidal margin or border.

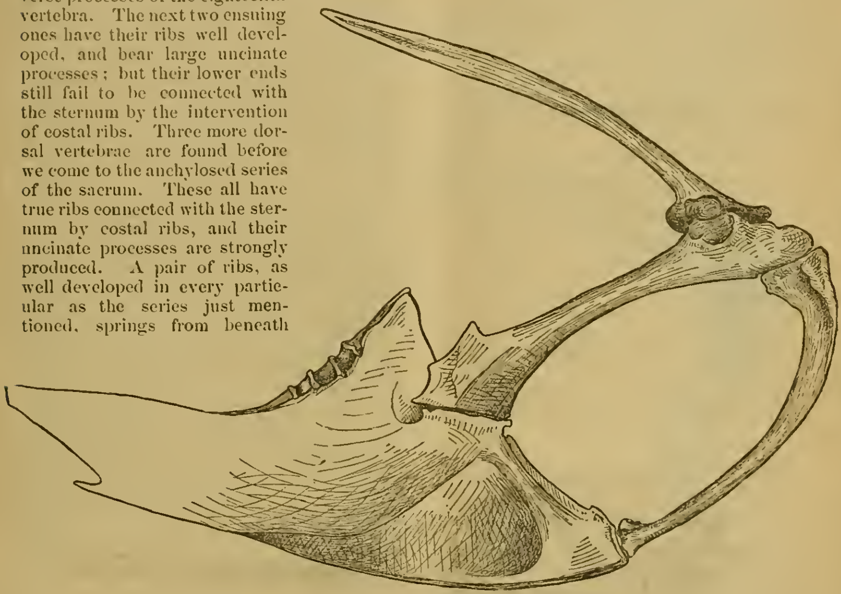


Fig. 2. — Right lateral view of sternum and shoulder-girdle of Phalacrocorax bicristatus, life size.

The keel is very much produced forwards, where, at its lower apex, it has a rough surface of some extent, against which the united clavicles abut. Sufficient material is not at hand for me to say whether anchylosis ever takes place at this point or not: it may do so, because we find in Aluco these bones usually unite at this point; but yet we come across specimens of this owl where the union is no more perfect than it is here. The hypocleidium of the clavicles, and the manubrium of the sternum, are both about equally feebly developed. The upper extremity of each clavicle has a very broad abutment for the head of the corresponding coracoid, to the inside of which expansion these clavicular bones throw backwards a scapular process; but they fail to reach these elements of the shoulder-girdle, as we find them

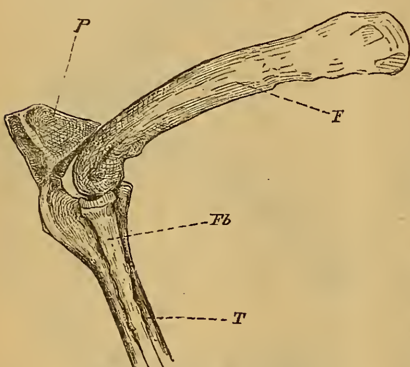


Fig. 3. — Knee-joint of Phalacrocorax bicristatus; right limb, life size. *F*, femur; *Fb*, fibula; *T*, tibia; *P*, patella.

in others of the class. All of the bones of the pectoral extremity, or the arm, are completely non-pneumatic, but otherwise well developed. Faint papillae for the quill-knobs of the secondaries are found along the entire length of the outer aspect of the ulna. The manus is composed of the usual number of bones,— one phalanx for index digit, two for the next, and one for the last.

In the lower extremity we find a femur of $6\frac{1}{2}$ centimetres in length; a tibia of $11\frac{1}{2}$; a metatarsus of 6; and the outer toe with five joints, measuring in all 10.7 centimetres. This limb is likewise non-pneumatic, in so far as its osseous structure is concerned. The fibula is carried unusually far down the side of its companion bone, to within 1.5 centimetres of the lower periphery of the outer tibial condyle.

The greatest interest, so far as the bones of the leg of this cormorant are concerned, centres about the knee-joint. Here we find a condition of affairs which is presented in my drawing. The femur, which is much roughened above for the attachment of muscles, articulates about equally with the leg-bones. In front of this joint is placed a very large and massive patella, of a pyramidal form, articulating with more than half its lower surface with the anterior and lower fifth of the femur, its inferior and anterior margin articulating at the same time with the upper border of the cnemial crest of the tibia. In front, we find that the groove that exists between the pro- and ecto-cnemial ridges of the tibia is produced on the entire anterior face of this patella, and, no doubt, the muscles of the leg are therein inserted, as in many divers. Such examples as this throw some light on such birds as Colymbus and Podiceps, where this bone becomes anchylosed with the tibia in the adult. I have not the skeleton of a loon at hand, to examine the process spoken of by Professor Owen ('Comp. anat. phys. vert.,' ii. 83), and followed by Dr. Coues in his osteology of the same bird ('Mem. Bost. soc. nat. hist.,' i. pt. ii.), as the analogue of the patella. The skeleton I have of Podiceps to examine does not show it; but it is one that has been in my collection for several years, and may have been lost. Penguins have a very large patella, that articulates with the tibia much in the same manner as it does here in Phalacrocorax. Professor Marsh describes a very large, free patella for Hesperornis regalis, and remarks that it bears a general resemblance to that bone in Podiceps ('Odontornithes,' p. 93). In examining this bone in the young of our cormorant, it seems to ossify from one centre. The ossification at the summit of the tarso-metatarsus includes the prominent process at the upper and posterior aspect of that bone.

Many other points of interest are to be found in the skeleton of the adult, as well as of the young of Phalacrocora xbicristatus, which space will not allow me to enter upon here: the leading points, however, I have endeavored to give, and these are always valuable when we wish to have them to compare with kindred forms.

R. W. Shufeldt.

THE ELECTRIC LIGHT ON THE U. S. FISH-COMMISSION STEAMER ALBATROSS. — I.

In pursuit of the hidden treasures of the deep, the work of the Albatross keeps her at sea many days at a time; and the operation of dredging in great depths often carries the day's labor past midnight. To provide for these emergencies, which are frequent, and to afford ample illumination for the naturalists, not only in assorting the contents of the dredge as it is delivered on deck, but to illuminate their microscopes, delicate balances, etc., in the laboratory, the commissioner of fish and fisheries determined to employ the best artificial illumination the country afforded. As the vessel is essentially a steamer, using steam for every labor where it is practicable, the idea of electrical lighting from a dynamo-electric machine, driven by a steam-engine, was readily conceived, and an examination of the different systems was at once entered into. The Edison company for isolated lighting, we found, was prepared to enter into a contract for a complete plant, including the engine and the wiring; and being able to divide the light into eight-candle power lamps, besides giving guaranties, their bid was accepted.

The arc-lamp, though admirable for our deck, where a great quantity of light in a limited space is necessary, can never, from its great brilliancy, be utilized for twelve or fifteen naturalists, each at a special work, in the laboratory. It also occurred to the commissioner, that a lamp which could be lowered into the sea, to attract fishes, would be useful, thus affording another reason for preferring the incandescent light.

Fig. 1 shows the way in which the arc-lights are placed in circuit. And as each arc offers a considerable opposing electromotive force, it is necessary, in order to get light in a number of such lamps placed in series, to use currents of high tension.

Fig. 2 shows the incandescent lamps in multiple arc. The main wires, *a* and *b*, are tapped at pleasure, and the lamps are hung in the short circuits. The carbon threads in the lamps (described beyond) offer so much resistance that the current heats them to incandescence. The electromotive force in the circuit is low, which renders shocks impossible.

The plant on board the Albatross consists of an eight and a half by ten Arminton and Sims engine, an Edison Z dynamo having its field-magnets vertical, a resistance-box in the circuit of the magnetic field, the main and branch wires, lamp-fixtures, safety-catches, and lamps.

The steadiness and uniformity of brightness of the lamps depend largely on the engine driving the dynamo; and the success of the system lies more in the attention paid to the engine, when the plant is correctly installed, than in any thing else. Uniformity of speed is the great object sought; and, to secure this, Mr. Edison has wisely adopted a high-speed engine with a sensitive governor, which is found in the Armington and Sims engine, represented in fig. 3.

The superiority of this engine lies in its well-

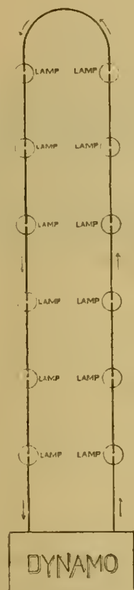


FIG. 1.

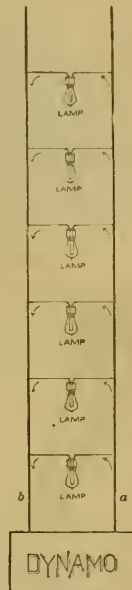


FIG. 2.

balanced working-parts, its relatively large bearing-surfaces, its sensitive automatic governor, and in its simple and well-balanced valve.

To secure high speed without the noise of 'thumping,' great lap has been applied to the exhaust side of the valve, whereby 'cushioning' is effected. This cushioning, or early exhaust closure, also effects a saving by retaining, in the clearance spaces, steam which would otherwise have been exhausted and wasted. To prevent an unequal expansion between the piston-valve and its chest, the castings are so made as to allow live steam to surround that part of the chest which surrounds the working-faces of the valve, as shown in fig. 4, in which S shows the steam space, and E the exhaust space. By this arrangement

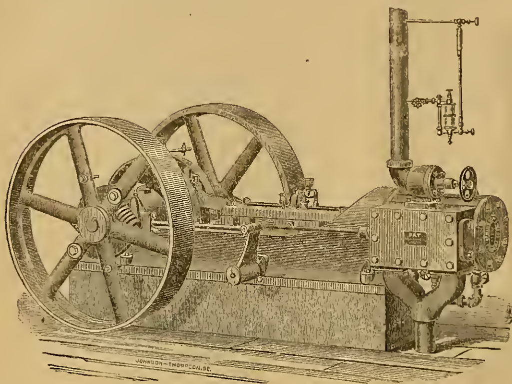


Fig. 3.

the valve-stem is packed against the exhaust instead of the steam pressure. The valve is ground to a sliding-fit, and, so far as I can ascertain, there has not been a particle of wear or leak during the ten months the engine has been in operation.

The governor of the engine, that part which makes it especially valuable for the purpose of electric lighting, is represented in fig. 5.

This automatic device is fixed in the fly-wheel, which is keyed to the shaft. There are two eccentrics, E and F, the one within the other, and both free to move on the axis. There are two weights, with their centres of motion opposite, and fixed in arms of the wheel. These

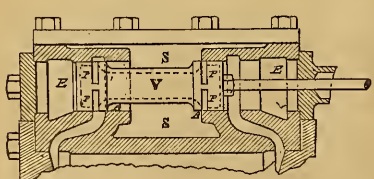


Fig. 4.

weights, W, W, are connected, each to an eccentric, and are connected together by an arm or rod. Springs are provided, to resist the centrifugal force of the weights. The system is so constructed that any centrifugal motion of the weights will throw one eccentric ahead and the other back, thus diminishing the throw of the eccentrics, and effecting a shorter cut-off without altering (within working limits) the lead of the valve. The engine used on board the Albatross has eight inches and a half diameter of cylinder, and ten inches stroke of piston: it runs without noise, three hundred revolutions per minute, requiring no more attention than the oiler can give it in addition to his other duties. When the main engines of the Albatross are in motion, a boiler-pressure of sixty-five pounds is often used, and twenty-six inches of vacuum is scarcely above the average. Lying in port, the boiler-pressure is kept at about twenty-five pounds; and, notwithstanding this great range of pressure, the governor regulates the dynamo to three hundred revolutions per minute, as closely as I can measure it.

In selecting a good engine, Edison has, to my mind, displayed as much genius as in using the Siemens form of armature for his dynamo.

The engines are placed on the starboard side

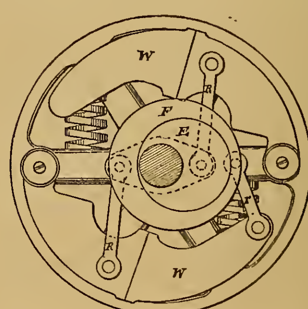


Fig. 5.

of the main engine-room, the engine taking steam from the main boilers, and exhausting into the main condenser.

The dynamo used on board the Albatross is known as the Z dynamo, and is installed for what is called a B circuit. It has its field-

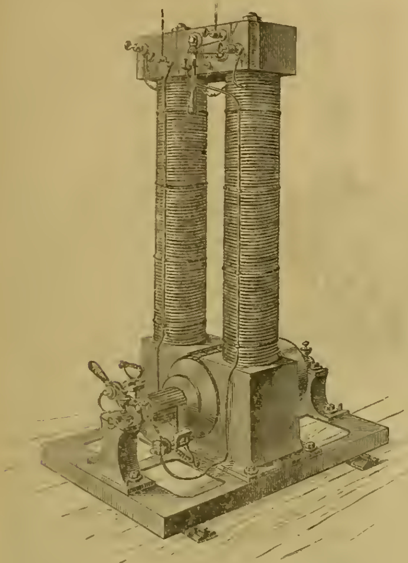


Fig. 6.

magnets vertical (fig. 6), and its armature revolves on a horizontal axis in the magnetic field. The field-magnets are arranged on what is called a 'derivation' from the commutator, placing it in the circuit, as in the Siemens system. In adopting and utilizing known principles and devices, Edison has worked out the details to a state of perfection simply admirable. Wherever the eye rests, it is pleased by correct proportions, sound mechanical ideas, and agreeable outlines.

The armature, on Siemens's principle, is mounted on a wrought-iron shaft. About the shaft, and concentric with it, are circular cylinders of wood, separating copper plates, as shown in fig. 7. Between the plates *a* and *b*, and also between *c* and *d*, there are annular disks of copper, insulated from each other. Between the plates *b* and *c* are similar but very thin annular disks of iron, separated from each other by tissue-paper. This built-up cylinder is then bolted together longitudinally; the bolts passing through the thin iron and copper disks without touching them, but clamping them between the thick plates. Wire bundles or bars are placed equidistant from each other longitudinally, around the cylinder, connecting each a pair of the copper disks, i.e., one at each end; and these bars or bundles generate the current.

Bars of brass or copper, separated by thin sheets of mica, *e,e*, are dovetailed into the projecting end of the cylinder, which forms the commutator. The resistance of the generator is thus small, and allows great subdivision of the current in multiple arc.

To preserve the uniformity of the current, an adjustable resistance-box is placed in the circuit of the field-magnets; and, when a number of lamps are extinguished, additional resistance may be added to the field by a switch on this resistance-box, whereby the internal and external resistances are balanced, preserving not only the uniform brightness of the lamps, but also the economy of the machine. A test-lamp is suspended on the dynamo; and the fireman, who oils the engine, regulates the resistance according to the brightness of this lamp. Automatic regulators have been devised; but as it is necessary to employ a man to run the engine and dynamo, and as the incandescence is more frequently altered by slipping of belts than by the sudden turning-out of a large number of lamps, the same man can attend both:

Fig. 7.

consequently the simple resistance-box answers every purpose on board ship.

(To be continued.)

THE AMERICAN EXPLORATIONS AT ASSOS.

THE excavations in the ruined Greek city of Assos, in the southern part of the Troad in Asia Minor, have been completed; and the members of the expedition have returned to this country. This gave occasion recently to call in Boston a special meeting of the Archaeological institute of America, under whose auspices the work had been carried on, at which Mr. J. T. Clarke, the leader of the expedition, was to give an account of his investigations. Unfortunately, Mr. Clarke was prevented by illness from attending; but this was less to be regretted, because it gave the president of the institute, Prof. C. E. Norton, an opportunity to express, more fully than he could otherwise have done, his sense of the extremely satisfactory manner in which Messrs. Clarke and Bacon had conducted the investigations at Assos.

Too strong terms could not be used to describe the devotion and self-sacrifice, as well as energy, which they had brought to the work, almost to the point of denying themselves the necessaries of life, that the resources of the institute might be diverted as little as possible from the work in hand. They had also labored in a spirit of enthusiasm and intelligence, bringing to bear the methods of modern scientific research, which gave to the results obtained an accuracy and value far beyond that of most of the archeological work of the past. No better archeological work had been done anywhere. He felt sure, that, when the final report upon the explorations at Assos should be published, it would be not merely up to the level of such publications, but would mark an advance in the science, and would take high rank among standard archeological works. This final report would require deliberate preparation: it was desirable that it should be exhaustive, and be published in a fitting style, as a monumental work.

The investigations had been carried out in the most thorough manner; nothing had been left undone which it was desirable to do; and, even had unlimited funds been at the disposal of the expedition, the excavations would not have been carried farther than they had been. The results were mainly architectural. A far more thorough knowledge of the civic buildings of a Greek city than was before possessed had now been obtained. Few marbles had been found (most of them having been previously destroyed), but a large number of terra-cottas were secured. The accession to the body of Greek inscriptions was real, though its importance was not to be exaggerated. In numismatics the expedition had been very successful; a very large number of coins having been found, and the number of types of Assian coins known, largely increased. In all, forty or fifty cases of antiquities would be brought home as the share of the institute. These included the best of the temple sculptures; the Hercules block and the best sphinx; all of the inscriptions, with the exception of the bronze tablet; a large number of terra-cottas; most of the coins, and a considerable number of minor objects, found in the tombs. Among the many architectural fragments, there would be enough to erect a complete order of the temple at the Museum of fine arts. The two thousand dollars which that institution had voted to appropriate for the purchase of a portion of the antiquities belonging to the Turks would fortunately not be called for, as the latter absolutely refused to sell any thing. Hope is, however, entertained, that a gift of these articles may be made by the sultan. It was pleasant to be able to announce that the whole work had been carried on with absolute honesty, and that the Turks had been dealt with in every way as strictly as if they had been Americans.

The final report would embody the results of all this work, published in an authoritative and reliable form. In the mean time a preparatory report would be issued, giving an account of the work done subsequently to the publication of the first volume on Assos. To prepare this report, it would be necessary for Mr. Clarke to go to London in order that he might have access to the British museum, the only place where the necessary materials could be obtained. It was desirable that the institute should retain both Mr. Clarke and Mr. Bacon in its employ until the Assos material had been entirely worked up.

The treasury of the institute was very nearly empty; and it was proposed to hold a general public meeting, at which Mr. Clarke, and other gentlemen interested in the subject, should speak, with a view to awakening such an interest in the community as should enable the institute to raise the sum of money required.

At this meeting, held Oct. 31, Prof. W. W. Goodwin read a report of the first year's work of the American school for classical studies at Athens, founded a year since by the Archaeological institute in connection with several of our colleges, and of which Professor Goodwin was last year the director. As this report affects rather the philological than the archeological student, and will be printed elsewhere, we proceed at once to the main feature of the evening, the address of Mr. J. T. CLARKE, who spoke substantially as follows: —

Assos was a small town, — small even for antiquity, when cities were very far from the enormous dimensions of modern capitals. The number of its inhabitants can never have greatly exceeded twelve or fifteen thousand; but its interest and importance can by no means be judged by that of modern towns of equal size. Athens itself, at the time of its greatest extent and power, is known to have had only ten thousand houses, and twenty-one thousand free citizens; and this figure included the entirely separate harbor-cities of Munychia and the Piraeus. To take a more recent example: the imperial city of Augsburg, at the epoch of its chief historical fame, under Maximilian, had only sixteen thousand inhabitants, — was only about the same size as Assos.

Our work gives as perfect a picture of the life of a quiet provincial Greek capital as the recent brilliant excavations at Olympia display the character of a great place of public festal assemblage. The investigations differ in scope; but I trust that ours has been not inferior as regards thoroughness, and, in some important respects, not as regards the nature of its results.

The first report, which is in your hands, represents three months' excavation. We have now the results of two years of hard work to add to it; and these results have been fully proportionate. The first report was restricted, in the description of buildings examined, to the temple and the Greek bridge. To our knowledge of these structures so many additions have now been made, that our restorations may be said to be as nearly perfect as it will ever be possible to attain. The temple, already better known than any building discovered in a similarly ruinous condition, appears as perfect an example for the history of Doric architecture as many which are standing to the top of the entablature. Other fragments of the reliefs carved upon its epistyle, the importance of which to the history of Greek sculpture is now recognized by all scholars, have been found since the publication of the report, and the entire stone ceiling of the building has been recovered. To this have been added many details, including most interesting and curiously suggestive observations concerniog antique stone cutting and laying.

Our knowledge of the geography of the land has been further enriched by maps, geological as well as topographical. To the story of its archeological recovery many details have been added, while its political history has received most important additions. One of these latter points I may be permitted to mention, because of its striking character. Assos is the first city of Greek civilization mentioned in documental history. The so-called Sallier papyrus, now in the British museum, records, that among the confederates who came to the aid of the Hittites, — those famous men whose empire is the pride of Professor Sayce, — were the 'people of Pedasa.' The inhabitants, then, of our city (Pedasos, Assos), were, in the fourteenth or thirteenth century B.C., of sufficient importance to be enumerated, with the Dardeni of Iluna (i.e., the Dardanians of Ilion or Troy), among those forces which appeared at Cadesh, on the banks of the Orontes, to fight against Ramses III. — the Rhampsinitos of Greek story — in the fifth year of his reign. The importance of this curious notice, in an historical point of view, is hardly to be overrated.

Fig. 1. — City walls of Assos, dating from the fourth century B.C.

The digging of the second and the third years has been almost restricted to the lower town. Much work was done upon the fortifications of Assos, the finest known works of Greek engineering. The oldest inhabitants settled close around the acropolis, building rough walls of enormous blocks, not cut by any metallic tools, upon the levels just at the foot of the volcanic crater, and there did a great deal of terracing, which was cleverly used by the later Greeks. The first outer circuit-wall remaining (I. in fig. 2) was certainly old at the time of the Lydian invasion. Under the favoring influences of the Aeolic colonization, the city greatly increased, and a new wall was necessary. This second masonry (II., fig. 2) may have somewhat antedated the Persian wars. By reason of the troubles brought by the Persian occupation of the land, the city declined; and when, under Lysimachos, its walls were rebuilt, the entire enclosure north of the acropolis was relinquished. The walls partially overthrown by sieges were not considered of sufficient value to be worth repairing, and a connecting-wall was built to the acropolis. This noble mass of masonry of the fourth century B.C. (fig. 1), rising in many places to some sixty feet in height, was joined so accurately that the blade of a pen-knife cannot be introduced between the stones. It was this portion of the wall that gave Col. Leake his well-known opinion that Assos was the finest representative of a Greek city in existence. Under the favorable dominion of the Romans, the commercial city greatly increased, and finally re-occupied the space north of the acropolis; new escarps (III., fig. 2) being built in front of the old walls, and enclosing them entirely. But to enter in any degree into details would lead us too far afield, ranging, as the fortifications do, through a thousand years, down to the time of Constantine; for the masonry in some parts, especially towards the eastern side of the city, closely resembles the ramparts of Constantinople.

The buildings of the agora, or market-place, of Assos, are so interesting and well connected that they are superior to those of all other Greek cities; and, notwithstanding the elaborate works of the many writers who have investigated and described the market-place of Pompeii, we may unhesitatingly assert the agora of Assos to be not only more interesting, but more completely known, than the forum of that city. The enormous stoa, or colonnade, a hundred and ten metres in length, was built, it may be with reason assumed, by the architect of that surrounding the temple of Athena Polias at Pergamon, which has so recently been excavated. It is constructed of the stone of the acropolis, an andesite much resembling granite; and a comparison between the forms given to this material and to the marble mouldings of Pergamon is most instructive. Being ceiled with wood, it needed only one support behind every second column of the front. Next to it, and apparently of the same date, is the bouleuterion, or building in which the archives of the city were kept. It is worthy of note, that most of the inscriptions were found in the slides of earth beneath this part of the agora, evidently having been thrown down during the troubles of the city. The building is exactly parallel in character to the only other bouleuterion known, —that in the Altis at Olympia; or, rather, it is like the inner portion of that structure, there being at Olympia halls on either side of a central structure like the bouleuterion of Assos.

The building which borders the agora on the south is absolutely unique. It is the only instance of a Greek bath known, and the only four-story ancient building ever recovered. Fortunately, we have been able perfectly to restore it. Its arrangement is extremely curious and interesting. It consisted of an enormous hall going through two stories, with twenty-six chambers upon its side. Above this entire structure was a colonnade, the floor of which was upon the level of the agora. In front of the stoa was an enormous basin for the reception of water, covered by stone lintels, and paved, so that it was not visible to the persons on the market-place. From it ran a subterranean conduit to the lower story of the bath-room, and there were arrangements for the water to flow into the thirteen lower cells. The refuse-water was then led into a larger basin beneath the bath-building. There was another reservoir to receive the water from its roof. This connected with the street, and so formed an enormous fountain, giving pure water for the consumption of the people; while the water of the refuse-basin adjoining it was used for the cooling of the theatre.

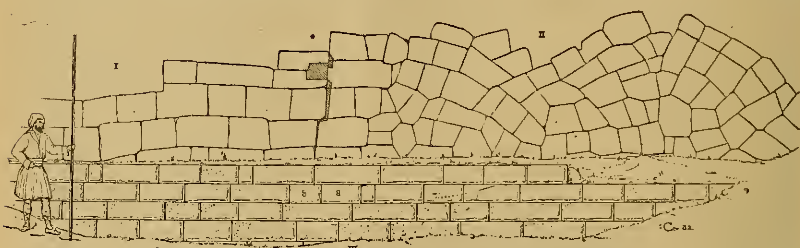


FIG. 2. — Corner of oldest polygonal city wall (I.), with extension in irregular masonry antedating the Persian wars (II.); both reveted, after the age of Lysimachos, with an escarp of squared blocks (III.).

Next to the bath was built, in later times, a small heroön, in which the bodies of the benefactors of the city were deposited, their names being inscribed on the entablature. We opened three sarcophagi, which contained only strigils, small vases, and the bones of the dead.

The changes of plan observable in the agora are peculiarly interesting. In early times there was an inclined plane ascending from a lower street to its level; but, when the heroön was intruded, the passage became so narrow that it had to be turned, and transformed into a stairway. Two fine mosaics of comparatively early date were found just below the retaining-wall. The larger represented Victories carrying votive offerings towards tripods, with a seller of love-gods as centre-piece; the other was bordered with geometrical figures, enclosing couching griffins, — the coat of arms of Assos. At the east of the agora was the bema, the stand-point of the orator in addressing a crowd; the level of the place being there raised above the market, and flagged, while the remainder, like all Greek streets before the Christian era, was unpaved.

Of the other buildings of the lower town, I may say that the theatre is now as well recovered as any theatre in Asia Minor. Because of certain peculiarities of the stage, its recovery is peculiarly valuable to the history of the Greek theatre. The gymnasium, at the west of the town, is equal in preservation and interest to the building of that character at Olympia, — the only one hitherto known. Noticeable, also, is a great atrium, of late date, but showing the preservation of Greek forms far into the Roman period, the arch appearing with purely Hellenic details. In the lower town of Assos there were no less than seven Christian churches. The street of tombs is perhaps the most interesting burial-ground of the ancients as yet thoroughly investigated. It presents monuments of every period. One, notably, cannot be later than the seventh century B.C., and many are as recent as the eleventh or twelfth Christian centuries. In this necropolis is a mausoleum which presents a perfect parallel to the tombs of the kings at Jerusalem. We opened a hundred and twenty-four sarcophagi for the first time, and found many burial-urns. There seems to have been a mixed system of inhumation and cremation, according to the temporary fashion. We also found great numbers of figurini, small vases and glasses, among them some beautiful specimens of thin transparent glass, and several thousand coins. Many other smaller articles of more or less value were found in the tombs; but the inhabitants of Assos, though they must have been wealthy, did not commonly place their best ornaments with the bodies of their dead.

It is my duty, as well as pleasure, to speak of the most creditable part taken by the members of the expedition not present here this evening. Of Mr. Bacon's really extraordinary ability as a draughtsman I have no need to speak. His unremitting labors secured the success of the expedition. The highest praise is due also to Mr. Koldewey, an architect from Hamburg, who worked with us for a year and a half from pure love of science, and was of the greatest possible assistance. My learned friend, Dr. Sterrett, has edited seventy-five or eighty inscriptions found by us, studying them upon the spot. Thanks, too, are due to our photographer, Mr. Haynes, and to Mr. Diller the geologist, who has already made known his work in valuable publications. Other members of the expedition, who were with us on comparatively short visits, worked as well and conscientiously, with results commensurate to the time they spent at Behram.

Archeology, up to within a recent date, hardly deserved the name of science, having been a merely empirical recital of facts, without connection or true historic method. To-day it has conquered a foremost place among the exact sciences of determination; and we trust that the study of the best methods of all previous investigations has enabled the expedition to Assos to be in every respect creditable to the American name. An instance of this special perception and direct search for materials bearing upon our knowledge of the development of various phases of ancient art may perhaps be seen in the fact, that two of the most interesting links that could be desired for Greek architectural history have been found, — a proto-Ionic capital, which stands between the ornamental spirals of Mesopotamia and the perfected Ionic capitals of the erechtheion; and a proto-Doric shaft with a base, which proves with equal certainty the derivation of that column from the tombs of Beni-hassan.

The work of the institute at Assos labors under one signal disadvantage: its results must be long awaited by those high-minded furtherers of science to whose munificence its execution is due. This disadvantage is indeed inseparable from all such undertakings of great extent; but on the other side of the Atlantic, where archeological investigations are carried on in greater part by the various governments, it is much less felt than here, where a large body of private individuals has maintained the work. There, the verdict of a commission of experts is entirely sufficient to the minister of public instruction, who has supplied the funds, and placed the diplomatic influence of the nation at the disposal of the work; and after this is given, a delay of ten or fifteen years in the publication of the results is not looked upon as a drawback. Here, however, the circumstances are different in every respect; and as it has naturally been impossible to give in half an hour any adequate account of the hard work of two long years, it only remains for me to beg for a further extension of credit. The debt shall be paid as soon as it is possible to write the proposed reports; and it will not have escaped your observation, that one object of the present meeting is to so interest you in the work of the institute, and convince you of its value, that the trifling sum required for these publications may be forthcoming.

At the conclusion of Mr. Clarke's address, Prof. W. R. Ware of New York was called upon, as one who had visited Assos for the express purpose of seeing what had been accomplished by the expedition. Professor Ware spoke as follows: —

It was, as you may believe, with special pleasure, that I found myself, in May of this year, passing through the Pillars of Hercules, my face towards the east, with the Troad as my objective point. But it was not until the third week in July, that, like St. Paul leaving Alexandria Troas, we came to Assos. though we were not, like St. Paul, 'minded to go afoot.' Perhaps it would have been better if we had been; for the modern Trojan horse is a small, ill-tempered, not always sure-footed, beast, who requires, indeed, often as much urging and pushing as did his Homeric namesake.

St. Paul probably passed through the valley of the Satnioeis, which flows into the Aegean on the west side of the Troad, a few miles south of Alexandria. But if he had known what was good for himself, in this world, he would have done as we did, and, leaving the plain, have ascended the steep sides of the little mountainous hill which separates the valley from the southern shore. There we found, upon the top, a tolerably level tableland commanding views of most surpassing beauty; to the north and west, Samothrace and Imbros and Lemnos, with Mount Athos just discerned in the western horizon on the other side of the sea; then, to the south, Lesbos, across the strait; and finally, in the gleaming morning sea, the little black hill which marked the volcanic mountain which was the goal of our endeavor.

The mountain of Assos is so steep as it rises out of the sea, that within a distance of half a mile it reaches a height of nearly one thousand feet. The steepest parts of the bridle-paths upon Mount Kearsarge and Mount Washington are not steeper than the road from the sea to the temple on the summit; and the agora, the market-place, which has been described to you, the centre of the city, is five hundred feet above the water.

One finds himself there, as you may now imagine, as on the stage of some classical theatre with all its scenes still standing, — here, the bouleuterion; there, the gymnasium, Mr. Koldewey's stoa, Mr. Clarke's temple and city walls, and, lastly, Mr. Bacon's street of tombs, leading half a mile away, towards his bridge at the river.

But interesting and exciting as is the presence of these monuments of antiquity, one can hardly keep his mind upon these things, for the attractions of the scene before him. To the east, where the long slopes of Mount Ida descend to the sea, the line is taken up by the blue and rose-colored mountains of Asia Minor, stretching along toward Smyrna; toward the south, filling the southern horizon, the island of Mitylene, — the mountain-tops brown in the sunlight, with purple shadows lying in all the valleys, and everywhere encompassing and infolding it all, the wonderful blues and greens of the Mediterranean Sea. Splendid as is the view from the acropolis of Athens, — the most famous in the world, — it seems to me that the view from the heights of Assos surpasses it in loveliness and splendor; and these buildings seem to have been so set, that this unparalleled prospect could be enjoyed to the utmost.

The buildings themselves are constructed of a stone which in its general aspect resembles a fine-grained granite, but in color and hue is more like the darkest and most purple of the Connecticut freestones. Yet the grain is so smooth that the most delicate mouldings can be cut upon it; and one is surprised to find, in passing the hand over the surface, how sharp, clean, and refined are the profiles of the mouldings.

The architectural interest attaching to these remains is unique. And here I cannot do better than to read an extract from a half-finished letter which I found in Mr. Bacon's portfolio, and snatched from oblivion, — a letter dated in December last, and never finished: —

"As the end approaches, my work has assumed a more definite form; and I know pretty well what the results will be. Hitherto I have been working rather blindly, and with but hazy ideas of final results. The street of tombs is such a collection of small, isolated ruins, that any thing like a complete idea of the original disposition was impossible at first. Sobered by the experience of last year, I this year attacked the monuments separately, with a resolute disregard of their relation to each other; excavated the most worthy, and drew them out in plan, elevation, and detail; then located each in a general survey, strung these plans along on a large map; and, lo, order is come out of chaos! Where before seemed nothing but confusion, now appears the hand of man; and the tombs are placed with such a picturesque regard for their purpose and for each other that the appreciative soul is filled with delight. The existing plan is more complete than the Appian Way at Rome, nearly as well preserved as that at Pompeii, and, to my mind, far more interesting than either, for it is pure Greek in every line and detail. Indeed, that may be said of all the work at Assos. There does not seem to be the slightest Roman influence. Of course, it is not always faultless. Work there is of all kinds, good, bad, indifferent, but, good, bad, or indifferent, Greek, not Roman. This absence of Roman feeling in the later work is a very peculiar thing. In Pergamon, Smyrna, and all the cities of Asia Minor, there exists a great deal of Roman work, and most of it pretty bad too. But here the bulk of the people probably never understood a word of Latin. The number of Latin letters upon the inscriptions we have found could almost be counted on your fingers. Whenever the Roman governors had any thing to say, they had to say it in Greek, to be understood. Even on the tomb of the Publius Varius family the dedicatory inscription over the doorway was in Greek.

"This absence of Roman work shows pretty well what a provincial town this must always have remained. Their stonemasons, builders, and architects were born and bred here; and they were a conservative set, with old-time notions about clamps and dowels, and about running down to the ledge for foundations. All this can be read like a book in the buildings we have laid bare. When any thing extra was to be 'run up,' they didn't import a foreigner from Miletus or Ephesus with his new-fangled ideas; not at all: they built it themselves. And this was not owing to lack of money, for the remains show that Assos must have been a wealthy city."

Another point of great interest is this, — almost all the principal publications of Greek work that have been made relate to monumental buildings. We have the temples, volume after volume, exhibiting a complete system of Greek architectural construction and design; but they have left unanswered the questions, how far Greek architecture was confined to sacred buildings, and to what extent the principles and methods which are exemplified in so magnificent a manner in the temples and sacred monuments were carried out in other structures. The long series of secular buildings which have been discovered at Assos offer the best answer that has yet been given to these questions; and the publication of the work, when it comes to be made, will mark an era in the study of the municipal and military architecture of the Greeks. It is a question, moreover, not without practical interest to the working architects of to-day, who are striving to solve for themselves the problem of fitly applying to secular and domestic buildings the same architectural forms, and the same principles of design, which they apply to sacred and monumental structures. This is an ever-recurring problem; and it cannot but be of service to learn how the Greeks, masters of the art, solved it in their own case.

Besides the walls, the buildings, and the tombs, there have been found, as Mr. Clarke has explained, a considerable amount of smaller objects, — vases, glass, pottery, urns, etc.; and of these a considerable portion has been secured as property of the institute. The *firman* by which the excavations were authorized gives us one-third of the objects found, — the most interesting third, perhaps; but it is difficult to speak justly in regard to it. If anybody should maintain that the objects which are to come here are of surpassing interest, and that they will immediately lift our museum to the front rank of such institutions, a decided negative would have to be given to such aspirations. If anybody should assert that the things were not worth the cost of transportation; that they have no general or popular interest; that they belong to a poor period; that they are hardly fit to be seen beside the more beautiful works, which, in the original and in copies, are in our possession, — that, again, could not be for a moment admitted; for the fact remains that the small portion which is secured to us is of surpassing interest to those who take an intelligent interest in such things at all.

The lower drum of a column, the capital, a complete section of the entablature, including the unique sculptured architrave, the frieze, and the cornice, all have been secured, and may soon be placed in position. In addition to that, the best of the sculptures which were discovered are to be brought over; almost all the coins; among the glasses and vases those which, on the whole, were best worth preserving; and most of the inscriptions. But even if the objects secured to us from the discovery were less than they are, it would make little difference in our estimate of the success of the expedition. The real result was intellectual. And the new points which have been proved, the new discoveries which have been made, are such, that, if not a single object were brought here from Asia Minor, we should still have abundant reason to be satisfied with the results achieved. It is impossible that we should obtain any adequate idea of these from the few drawings that have been publicly shown. They are but a fragment of the whole.

How it was possible for these two or three young men, while occupied with the practical direction of from twenty to forty men, to make the surveys and supervise the excavations, and also to prepare the immense mass of drawings which have been executed, it is difficult to understand; and it furnishes abundant proof of the ability and devotion with which the work has been prosecuted. The nature of the results will be seen when the next annual report comes from the printer; but their whole value and importance cannot be estimated until the appearance of that final and monumental work which will, we may hope at no distant day, take rank among the authoritative publications of its kind.

I may add, that the increasing interest in archeological work, and the scientific and precise manner in which it is now conducted, give new encouragement to the prosecution of literary classical study. The competition between the literary and scientific method seems about to end in a reconciliation, in the prosecution of literature on scientific principles, and in allying archeological science as closely as possible with the literature of classical antiquity. Archeology is a common ground on which science, literature, and art meet and join hands, each helping the other. Such a school as that now established at Athens, which you are asked to favor with your approval, is their common home.

On motion of the Rev. Phillips Brooks, the meeting declared, by an enthusiastic vote, that the work of the institute should be generously supported.

THE AMERICAN ORIENTAL SOCIETY.

THE autumn meeting of this society was held in New Haven, Oct. 24 and 25. Letters were read from various members abroad, reporting progress in their work; among others, from Mr. Mills of Hanover, respecting his edition of the Old Persian Gathas (ancient Zoroastrian songs or odes), of which the first volume is printed, though not published.

A paper on the temple to Zeus Labranios in Cyprus was read by Mr. Isaac H. Hall of Philadelphia, one of the pioneers in Cypriote studies, and the chief authority on the Cypriote language in this country. A temple to this deity exists at Mylasa in Caria (described in Fellowes's 'Lycia'). He was, under the name of Zeus Stratios, a local deity of the Mylasians, certainly from the time of Darius to that of Lactantius. The only other temple to him is this one in Cyprus, at Fasuli (or Fasula), near Amathus. The notoriously Lycian-looking architectural and other art remains found in the neighborhood show that this part of Cyprus was settled by Carians from Mylasa or its vicinity. Mr. Hall derived the epithet 'labranios' from a Lydian, Carian, or Lycian word, 'labru' (preserved by Plutarch in the form 'labrus'), meaning 'axe,' the axe being the peculiar symbol of Zeus Stratios of the Mylasians. From this word came the Mylasian name 'Labranda' ('place of the axe'); but the Carian settlers in Cyprus dropped the *d* (which is a sort of locative termination), and called their deity Zeus Labranios; that is, the Zeus Stratios of the Mylasians, and not Zeus Labrandios, which would be the Zeus of the village Labranda. Lycian influence in Cyprus seems confined to this little part of the island.

Mr. Hall also read (supplementing it from his own knowledge of the facts) a short history, from Dr. Van Dyck of Beirut, of his Arabic translation of the Bible, — a version admirable in literary style and in typographical execution (printed at the American press in Beirut). The difficulties in the way of the production of this translation were very great, and the result is highly creditable to American scholarship and energy.

Professor Avery of Bowdoin college gave an analysis of the Khasi language, spoken by a people dwelling in the Nepaul Hills, a representative of the non-

Aryan dialects which preceded the Sanskrit in India. It has no inflections proper, but uses prepositions for the expression of case-relations, and forms tenses very much in the same way as the English. It is noteworthy that this language, though a slightly developed one, has a clear distinction of gender; but the value of gender-distinction as a linguistic differentia is not yet well made out. In common with most of the languages of eastern Asia, the Khasi has a system of tones. The same thing is true of the Siamese, on which Mr. George presented a paper, illustrating the tonic distinctions by a short Siamese reading.

The paper of the most general interest was one on the origin of the Phoenician alphabet, read by Mr. J. P. Peters of New York. For some years past, most students of the subject, accepting for the present the conclusions of the late Vicomte E. de Rougé, have been inclined to derive the Phoenician from the Egyptian. This conclusion is based on the close relations existing between Egypt and Phoenicia in historical times, and on the similarity between certain letters in the two alphabets. But recently the Babylonian-Assyrian alphabet has begun to press its claims to be considered the parent of the Phoenician. It is almost certain that Phoenicia was closely connected with the Tigris-Euphrates valley at a time earlier than the oldest known historical monument. As long ago as 1877, a German scholar, Deecke, came forward as the champion of the Babylonian alphabet; but he committed the anachronism of deriving the old Semitic or Phoenician from the more modern 'cursive' cuneiform. Mr. Peters took the most ancient cuneiform signs, and compared them with the oldest Phoenician, finding in several instances striking resemblances. He urged besides, against the Egyptian origin, the fact that the Phoenician alphabet contains no vowels, while the hieroglyphics have distinct vowel-signs [though this is true of the Babylonian also]; and, further, the fact that the Egyptian had a large number of different signs for the same sound, and would present greater difficulties in the way of deriving an alphabet than the Babylonian, which had fewer homophones. The question is yet far from being settled, one serious obstacle in the way of the Assyriologists being the difficulty of determining the oldest forms of the cuneiform writing; but all such sober investigations as that of Mr. Peters must advance the desired solution. Meantime the Egyptologists, on their part, are bringing forward new material.

The edition of Manu, which was undertaken by the eminent English Sanskritist, Mr. Burnell, has been committed by the publishers, since his death, to Mr. E. W. Hopkins of New-York City, who sent on two papers, — one on the Nandini commentary on Manu, the other on the quotations from Manu in the Mahabharata. The former was a defence of the commentary in question: the latter was a contribution to the criticism of the Manu text. Mr. Hopkins took those passages in the Mahabharata which are introduced by the phrase, 'Thus said Manu,' and, finding that they do not always agree with the existing text of the laws, concluded that both texts rest on an older tradition; that Manu was an ancient sage, with whom tradition connected a number of laws, whence grew the collection called by his name.

Professor Whitney read on the variants of the Sama-Veda, coming to the conclusion (against the position of Benfey and Weber, hitherto generally accepted), that, in most cases in which the Sama text differs from that of the Rig, the latter is entitled to the preference. Professor Bloomfield of Johns Hopkins university, who is engaged in editing the Kauçika-Sutra to the Atharva-Veda, sent an account of the manuscripts of the Sutra in his hands, most of which he had obtained through the kindness of English officials. Mr. Brown made a short report of the recent Oriental congress in Leiden, at which he was present.

The next meeting of the society will be held in Boston, May 7, 1884.

LETTERS TO THE EDITOR.

Geology of Philadelphia.

DR. PERSIFOR FRAZER's explanations of his use of the term 'hydromica slate,' in his Lancaster-county report, as either 'not an equivalent for hydromica schist' or as a 'misprint,' renders it evident that he has changed his opinions since the writing of his report on York and Adams counties. In that volume the term 'hydromica slate' is employed ten times or more to designate 'hydromica schists,' and in several instances the terms are used synonymously. In two instances, localities marked in his printed section as hydromica schist are referred to in the accompanying descriptive text as hydromica slate (v. sections 2 b, 4, and p. 94, 101). As is evident from the context in a number of places, his 'hydromica slate' does not mean 'chlorite slate,' but 'hydromica schist' as it is elsewhere called (v. p. 83, 142, etc.).

There is, however, equal objection to his use of the term 'chlorite slate,' frequently employed in his different reports to distinguish greenish portions in the hydromica series. These are no more slates than are portions of the adjacent hydromicas, which are of identical structure. Nor, indeed, are they true chlorites, having but a low percentage of magnesia. (A recent analysis of some of the greenest of this so-called 'chlorite slate,' made for the writer by Prof. S. P. Sharples, gave only 4.28% of magnesia.)

Hydromica slate, as meaning hydromica schist, is also used several times in the report on Chester county, and the synonymous terms 'talc slate,' 'mica slate,' 'talc-mica slate,' 'talc-mica schist,' 'micaceous talcose slate,' and 'South Valley Hill slates,' are employed more than fifty times in the same report without distinction between slate and schist. Professor Rogers, as is well known, used most frequently the expression 'talc-mica slate.'

That the term 'slate' has been used synonymously with 'schist' in the region of the South Valley Hill, is not only shown by the indiscriminate use of those terms by Rogers, Lesley, and Hall, but is apparent in a remark by Dr. Frazer himself in the Chester-county report, p. 279, where he says: —

> "South of the Valley limestone, which only touches the extreme angle of the township, are hydromicas and mica-schists, dipping about south 35°, east −62°. The southern contact of limestone and *slate* occurs in this corner. . . . The hydromica schists and mica-schists to the south, which enclose this, are principally vertical," etc.

Now, as the only slates which occur at this locality are hydromica slates belonging to the hydromica series of rocks of the South Valley Hill, these must be the slates referred to, even if 'hydromica slates is a contradiction in terms.'

While the undersigned certainly does not intend to be a champion for the term 'slate' instead of 'schist' for these rocks, good reason for the use of that term lies in the slaty character of many of these hydromicas as distinguished from the contorted and schistose character of the micaceous rocks of other regions.

The writer's use of the expression 'hydromica slate' in describing the Edge Hill and Barren Hill rocks (the 'altered primal slates' of Rogers), is thought preferable to the term 'hydromica schist,' since large portions of that formation are slaty rather than schistose. The greater part of the formation is a slaty sandstone or quartz slate, and, where outcropping in Chester county, is so designated by Dr. Frazer. It might naturally be taken for granted that the writer believes, with Dr. Frazer, that the hydromica schists and slates of the South Valley Hill of Chester county are about contemporaneous with this quartz slate or Edge Hill rock.

In order to prevent future misapprehension, it may here be stated, that the writer has been led to the conclusion that the two formations are distinct, and that both Professors Rogers and Frazer have confounded two rock series belonging to different geological horizons, — the one, Cambrian; the other, Silurian. The analogue of the Edge Hill rock is believed to occur in Chester county, on the south side of the hydromicas of the South Valley Hill. The facts leading to this conclusion have been gathered during some extended field-work in Chester county, and will shortly be published. Meanwhile, the remarks upon the primal slates made in the Franklin institute lecture should be understood as referring solely to the Edge Hill rocks proper, and not to the South Valley Hill schists or slates, which are but poorly defined in the vicinity of Philadelphia.

H. CARVILL LEWIS.

The specific distinctness of the American and European brine shrimps.

In Professor Smith's notice of our 'Monograph of phyllopod Crustacea,' he states, that, in the portion relating to the above subject, 'there is certainly confusion,' and quotes two paragraphs relating to the females alone, and finally remarks, "but differences like these in statements of observation betray inexplicable carelessness."

After quoting the two paragraphs relating to the *females alone*, it seems to us a careful critic would have also taken pains to have quoted the longer paragraph relating to the males, which directly follows the first paragraph quoted by our critic. To allow the two paragraphs relating to the females to be so widely separated was an oversight on the part of the author, who, however, thought that he had taken a good deal of pains to show the specific distinctness of the American and European species. Two sets of females from different localities, named by different persons, were examined at different times; and this explains how the two paragraphs became placed too far apart in the author's copy. It would have been better, of course, if the author had added a few words, and dogmatically stated that the two species were undoubtedly distinct. He preferred not to do, or omitted to do, this, but gave in considerable detail, and in as judicial a way as possible, the facts of the case. At first it was 'difficult to find good differential characters' between the females, and those found are but slight ones. The females of any of the species of Artemia, Branchinecta, or Branchipus, do not exhibit good specific characters; but the males do, as the author attempted to show. If the author failed in directness of statement on this subject, or led to any confusion in any one's mind, he sincerely regrets it: on the other hand, he doubts whether there were, in the case, reasons for the charge of 'inexplicable carelessness.'

The paragraph which Professor Smith would have done well to have quoted is the following one: —

"Upon comparing a good many males from Great Salt Lake with several, both stained with carmine and unstained, received from Cagliari, Sardinia, through Prof. J. McLeod of Ghent, the European A. salina is seen to be considerably stouter, the head wider, the eye-stalks longer and larger, and the eyes larger. The frontal button-like processes of the first joint of the claspers are nearly twice as large as in the American species, and a little more pointed, while the claspers themselves are larger and stouter. The legs and sixth endites are of about the same form. The most apparent difference is in the caudal appendages, or cercopods, which in A. salina are several times larger than in A. gracilis, being in the Sardinian specimens nearly three times as long and much larger than in our species. In this respect, the genus shows a close affinity to Branchinecta. However, in a lot of A. salina ♀ from Trieste, the cercopods are very much shorter than in the Sardinian females, and only a little longer than in our American specimens. These appendages do not differ in the two sexes."

A. S. PACKARD, Jun.

Bone fish-hooks.

Recently, while digging in a shell-heap near Narragansett Pier, Rhode Island, I found among broken arrow-points, and fragments of bone, pottery, and shells, a nicely worked bone-hook, and also the shanks of three other apparently similar hooks; while in a neighboring shell-heap two more fragments were found.

The perfect hook measures a little more than one inch in length, and a little less than one inch across from the shank to the point, the latter being nearly as long as the former. The shank is flattened and notched at the end, forming a sort of head, somewhat similar to the fish-hooks of the present day. This hook, although much shorter, resembles a hook from Long Island described and figured by Mr. Charles C. Abbott on p. 208 of his work on Primitive industry. Of this he says, "Objects of this character are exceedingly rare, either as found on the surface, or in shell-heaps. While of so simple a form, bone fish-hooks of this pattern do not appear to be common in any locality in eastern North America."

Figures are here given of the perfect hook, and the fragments of three others which appear to be precisely similar. Margarette W. Brooks.

Nov. 1, 1883.

Supposed glacial phenomena in Boyd county, Ky.

A part of the work devolving upon us who have recently been tracing the southern boundary of the glaciated area in America, has been to follow up the reports of glacial phenomena south of our line.

Boyd county, Ky., having been referred to by a number of authorities as such a locality, I was naturally led to visit it a short time since; and I found, to my satisfaction, that that region was never directly glaciated.

Boyd county is in north-eastern Kentucky, bordering upon West Virginia, and upon the remarkable bend of the Ohio River where it receives the waters of the Big Sandy. Through the attention of Mr. John Campbell of Ironton, O., and Mr. J. H. Means of Ashland, Ky., I was assisted in making a pretty thorough examination of the region. Upon going back about two miles into Kentucky from the Ohio River, opposite Ironton, we find ourselves in a valley two miles wide, running parallel with the Ohio River, and two hundred and twenty feet above it. This valley extends for many miles, reaching the river towards the west at Greenup, and continuing some miles, at least, above Ashland. It is known as Flat Woods. The level is remarkably uniform; and the hills upon either side of it rise about two hundred feet, with numerous lateral openings towards the Ohio. When upon the farther side, and looking northward, one sees the rocky bluffs of the old channel rising so like those facing the river itself, that he can scarcely resist the illusion that he is in the present valley of the stream. The supposed glacial phenomena consist of numerous water-worn pebbles of quartz and quartzite scattered along the whole range of this old valley. Most of the pebbles are small, and perfectly rounded, though some were a foot or more in diameter; and one observed was about two feet and a half through, and only slightly worn. These pebbles are not found upon the hills back from this channel, on the Kentucky side, nor, according to Mr. Campbell, who is a most competent witness, anywhere in Lawrence county, O., back from the river. Plainly enough, they are the result of water-transportation. Whether they were deposited at the very early period when the Ohio flowed at the level of two hundred and twenty feet higher than now, and regularly occupied this old channel, or whether they were brought into place during the existence of the glacial dam which I have supposed at Cincinnati, I will not venture to say; though the latter theory would seem more in accordance with the facts published by Professor White concerning the old channel followed by the Chesapeake and Ohio railroad, extending from the Kanawha River to the mouth of the Guyandotte in West Virginia. The elevation of the Kanawha-Guyandotte channel is nearly the same as that of the one I am describing, and this seems to be a prolongation of that. At any rate, the pebbles can only be indirectly referred to glacial action.

Now that attention is directed to this class of investigations, it would seem to be important for Professor Lewis to give through your columns, or somewhere else, publicity to his investigations of the facts supposed to indicate glacial action in Pennsylvania farther south than the boundary-line indicated by our investigations two years ago.

G. F. Wright.

Oberlin, Nov. 5, 1883.

Elliptic elements of comet Pons-Brooks.

While the orbit by Professor Boss, published in Science, No. 34, represents observation so well that there can be no doubt of the identity of the two comets, still it is of interest to know how closely elements derived from observations of the present comet alone agree with those of the Pons comet.

The arc of anomaly already passed over is only about twelve degrees, — a condition very unfavorable to the precise determination of elements, and inadequate to determine a reliable periodic time.

On account of this, in the solution of the equations, Δe was considered as a known quantity, and finally an assumed value substituted for it.

I find the following corrections to Professor Boss's elliptic elements from the normal places given below: —

$$\begin{aligned}\Delta\pi &= -194.0'' - 78{,}768.\ \Delta e\\ \Delta\Omega &= +\ 19.5'' + 289{,}233.\ \Delta e\\ \Delta i &= -\ 57.5'' + 55{,}256.\ \Delta e\\ \Delta T &= -\ 0.065235 - 108.39\ \Delta e\\ \Delta q &= +\ 0.000716 - 0.04\ \Delta e\end{aligned}$$

Assuming the eccentricity to be 0.954996, which closely approximates to the true value on the hypothesis of identity, we have for Δe, -0.000274.

The resulting corrections to the preliminary elements are, —

$$\begin{aligned}\Delta\pi &= -172.4''\\ \Delta\Omega &= -\ 59.7\\ \Delta i &= -\ 72.6\\ \Delta T &= -\ 0.035537\\ \Delta q &= +\ 0.000727\\ \Delta e &= -\ 0.000274\end{aligned}$$

and the corrected elements are, —

$$\begin{aligned}T &= 1884,\ \text{Jan., } 25.66046\\ \Omega &= 254^\circ\ 07'\ 48''\\ \pi &= 93\ \ 18\ \ 50\\ \omega &= 199\ \ 11\ \ 02\\ i &= 74\ \ 02\ \ 05\\ lg\,q &= 9.889708\\ e &= 0.954996\end{aligned}\quad \left.\right\}\ 1883.0\ (\Omega,\ \pi,\ \omega,\ i)$$

After obtaining the preceding results, the equations were solved for the value of Δe, with the result $\Delta e = -0.000032$; but no use was made of this.

Normal places, 1883.0.

Mean date, Greenwich mean time.	α	δ	No. of observations.
	h. m. s.		
Sept. 8.5 . . .	16 30 38.75	63° 49′ 12.5″	28
" 22.5 . . .	16 25 17.65	60 45 52.3	16
Oct. 6.5 . . .	16 30 28.52	57 42 35.9	8
" 20.5 . . .	16 45 00.31	54 50 37.4	6

These normal places are represented by the corrected elements, as follows: —

C − O.

	$\Delta\alpha\cos\delta$.	$\Delta\delta$.
I.	−0.5″	+1.3″
II.	−1.2	−0.1
III.	+4.4	+0.9
IV.	−0.8	−1.2

The last two places depend entirely upon Albany filar-micrometer observations.

In order to form some idea of the accuracy attained in modern observations of faint comets, the following table of comparisons, with the corrected elements, may be of interest. The comparisons are not very rigorous, and are liable to accidental errors of one or two seconds.

C — O.

Date, Greenwich mean time.	Observatory.	Δα cos δ.	Δδ.
Sept. 3.6 . . .	Harvard . . .	[21″	3″]
" 4.7 . . .	Harvard . . .	+ 9	6
" 4.7 . . .	Harvard . . .	[+ 23	− 3]
" 4.7 . . .	Harvard . . .	[+ 22	− 2]
" 5.4 . . .	Kiel	− 10	+ 14
" 5.5 . . .	Albany	− 3	− 7
" 5.5 . . .	Harvard . . .	[+ 12	4]
" 5.5 . . .	Wien	4	+ 1
" 5.6 . . .	Albany	− 3	+ 11
" 5.6 . . .	Cincinnati . . .	0	+ 12
" 5.6 . . .	Leiden	− 2	10
" 6.4 . . .	Königsberg . .	[+ 12	− 26]
" 6.4 . . .	Dun Echt . . .	2	+ 3
" 6.5 . . .	Harvard . . .	[+ 12	− 5]
" 6.6 . . .	Albany	− 3	+ 2
" 6.6 . . .	Albany	5	+ 10
" 6.6 . . .	Harvard . . .	1	10
" 6.6 . . .	Cincinnati . . .	3	+ 3
" 6.8 . . .	Harvard . . .	[+ 22	0]
" 7.3 . . .	Wien	− 5	+ 4
" 7.4 . . .	Kiel	− 4	+ 1
" 7.5 . . .	Harvard . . .	[+ 17	+ 10]
" 8.4 . . .	Leiden	3	− 3
" 8.4 . . .	Dun Echt . . .	− 4	− 9
" 9.3 . . .	Pulkowa . . .	3	0
" 9.4 . . .	Kiel	2	2
" 9.5 . . .	Strasburg . . .	− 1	3
" 9.6 . . .	Albany	− 1	2
" 9.6 . . .	Harvard . . .	+ 2	− 15
" 10.4 . . .	Pulkowa . . .	+ 4	+ 2
" 10.5 . . .	Kiel	1	+ 6
" 10.5 . . .	Dun Echt . . .	+ 1	+ 1
" 10.5 . . .	Strasburg . . .	− 2	0
" 19.8 . . .	Cincinnati . . .	+ 7	5
" 11.5 . . .	Kiel	− 9	5
" 11.6 . . .	Dun Echt . . .	5	+ 5
" 17.3 . . .	Pulkowa . . .	+ 6	− 3
" 18.5 . . .	Albany	1	+ 7
" 19.3 . . .	Kiel	0	− 1
" 19.4 . . .	Strasburg . . .	3	4
" 21.4 . . .	Strasburg . . .	− 1	5
" 21.6 . . .	Albany	3	1
" 21.6 . . .	Albany	0	− 7
" 22.3 . . .	Königsberg . .	1	+ 6
" 23.3 . . .	Wien	5	− 2
" 23.3 . . .	Kiel	6	2
" 25.4 . . .	Leiden	− 3	+ 6
" 25.6 . . .	Albany	+ 11	− 6
" 25.6 . . .	Albany	+ 7	+ 5
" 26.6 . . .	Albany	1	7
" 26.6 . . .	Cincinnati . . .	9	9
" 26.7 . . .	Albany	3	3
Oct. 3.6 . . .	Albany	+ 5	2
" 4.6 . . .	Albany	+ 3	3
" 4.6 . . .	Albany	+ 6	0
" 4.6 . . .	Albany	+ 3	− 2
" 5.5 . . .	Albany	+ 1	+ 4
" 7.6 . . .	Albany	+ 6	+ 2
" 7.6 . . .	Albany	+ 3	2
" 9.5 . . .	Albany	+ 8	+ 5
" 16.5 . . .	Albany	0	9
" 17.5 . . .	Albany	2	0
" 18.5 . . .	Albany	+ 6	+ 1
" 21.5 . . .	Albany	5	0
" 24.6 . . .	Albany	4	+ 5
" 25.5 . . .	Albany	− 3	− 5

The observations enclosed in brackets were not used as exhibiting large systematic or accidental errors.

A few observations were made with ring-micrometers, but it is not possible to determine how many. At Albany the ring was used until Sept. 21, afterwards the filar micrometer.

The following table shows the constant difference for each observer when there are three or more observations given, and includes nothing later than Sept. 26: —

Observatory.	No. of observations.	Δα cos δ.	Δδ.
Albany, B.	8	1″	0″
Albany, E.	4	+ 2	3
Cincinnati	4	0	7
Harvard, Wn.	7	+ 18	2
Kiel	7	− 5	+ 4
Leiden	3	− 3	+ 4
Pulkowa	3	+ 4	0
Strasburg	4	− 1	− 3
Wien	3	− 1	+ 1

These constant errors, though founded on rather slender material, probably represent fairly what is to be expected from modern observations of comets.

Following are the heliocentric co-ordinates: —

$$x = r\,(9.580346)\sin(153^\circ\ 14'\ 15.1'' + v)$$
$$y = r\,(9.996200)\sin(\ 82\ \ 04\ \ 40.0\ + v)$$
$$z = r\,(9.970401)\sin(174\ \ 59\ \ 17.4\ + v)$$

H. V. EGBERT.

Dudley observatory, Albany, N.Y.,
Nov. 6, 1883.

Rapid geological changes in Alaska.

Mr. Dall kindly calls my attention to an error in the note of my remarks, given in SCIENCE of Oct. 19. Hood's Bay is nearly a degree south of the locality of the submerged forest described. Looking at my diary, I find the entry 'Hoona,' which is, I believe, synonymous with 'Bartlett Bay' of some charts. While making my verbal remarks at the academy, I mistook my pencilling of 'Hoona' for 'Hood.' The exact location of the forest is latitude 58° 27′, longitude 135° 40′. I am very much pleased to find from Mr. Dall's letter that my view of the modern changes, drawn from botanical facts chiefly, derives support from some geographical evidence within his reach.

THOMAS MEEHAN.

The mechanism of direction.

I read with interest Professor Newcomb's article on the sense of direction (SCIENCE, Oct. 26). Professor Newcomb says nothing about the behavior of the subjective co-ordinates under a slight change of angle. My experience in this respect I give below, and I have reason to believe the experience to be quite general.

The street A B turns into B C. Walking from A to B, my co-ordinates begin to change when about a hundred yards from B. By the time I get to B, or rather just after B, they have changed by the angle A B C, no matter how large or how small A B C is. The same takes place in going from C to B to A. While close to B on either side, I can by an effort imagine myself under the old co-ordinates; but the new ones are much more natural. In the dark, I think the turn is not seen so far ahead, and the change takes less time. If I go from A to B, with my eyes turned towards A, I have a different experience. I have never tried it by *walking* backwards; but I have observed my sensations while riding on the back platform of a street-car. As the car turns at B towards C, and I am looking towards A, my co-

ordinates begin to change rather suddenly; but there is no sign of a change before B. Shortly after B, I still can conceive myself under the co-ordinates formed on A B, by a mental effort. After about a hundred yards the new co-ordinates have entirely displaced the old.

At the corner of 13th and Spring-Garden streets in Philadelphia I had an experience like that of Professor Newcomb. For a long time I could not approach the place, riding or walking, without my co-ordinates changing by 90°. I cannot account for it. Gradually it wore off, and now no change takes place.

JOSEPH JASTROW.

Johns Hopkins university, Nov. 6.

INTERNATIONAL GEODETIC ASSOCIATION OF EUROPE.

Verhandlungen der vom 11 bis zum 15 September 1882, im Haag vereinigten permanenten commission der europäischen gradmessung. Redigirt von A. HIRSCH und T. VON OPPOLZER zugleich mit dem general bericht für die jahre 1881 und 1882. Berlin, *Reimer*, 1883. 6+155 p., 2 maps. 4°.

THE proceedings of the annual meeting of the committee at The Hague, Sept. 11 to 15, 1882, have just been published. The permanent committee consists of the following members: Lieut.-Gen. Ibañez of Madrid, president; Dr. von Bauernfeind, vice-president; Dr. Hirsch of Neuchâtel, and Dr. von Oppolzer of Vienna, secretaries; Mr. Faye of Paris; and Major-Gen. Baulina of Florence. The delegates, eleven in number, represent most of the countries of Europe. Some invited guests also attended the meeting. The session was opened by the minister of state, Rochusson of Holland, who extended to the members a cordial welcome, which was responded to by President Ibañez.

The last meeting was held at Munich in 1880; but the commission resolved to omit the contemplated meeting for 1881, in order to give its members an opportunity to attend the Geographical congress at Venice: the reports therefore submitted by the several representatives cover the work done, or in active progress, during the two years 1881 and 1882. Secretary Hirsch alludes to the loss sustained by the association since its last conference, in the death of Dr. Carl Bruhns, a member of the commission since 1864; in the death of Gen. de Ricci, one of the veterans of Italian geodesy; of Col. Adan of Belgium, and Professor Stamkart of Holland. The latter had shown that the mean level of the North Sea had not changed during the past hundred and fifty years with respect to the zero of the tide-gauge at Amsterdam. And, last, the association had to mourn the loss of Professor Plantamour of Geneva, whose labors in astronomy and physical geography are so well known, and to whose zeal the recent developments in levels of precision and the progress made in pendulum observations are so largely due.

The Italian commission was increased by Professor Fergola of Naples, by Professor Celoria of Milan, and by Lieut.-Col. de Stefanis of Florence. Austria nominated Capt. von Kalmar and Professor Herr as commissioners; Holland completed its representation by Professor Schols of Delft; and Roumania sent Major Capitancanu. The honorary president and founder of the association, Major-Gen. Dr. Baeyer, who, on account of ill health, was unable to attend, presented a report of the labors of the Geodetic institute of Prussia during 1881–82. He makes mention of the success of the experiments[1] to determine the difference of temperature between the bars of platinum and brass of the Brunner base-apparatus by means of thermo-electricity. The researches for local deflection of the vertical were extended from the Harz to the shores of the Baltic and the North Sea with the result of proving it a region of predominating negative (A.—G.) deflection, varying between 4″ and 7″. A list is presented of seventeen works published by the institute during the interval. Several of these relate to levels of precision; and the pamphlet by Dr. Sadebeck, entitled 'Literature of the practical and theoretical measurement of arcs,' deserves special mention. In a discussion closing the first session, relative to the probable error in the assigned length of the pendulum, it was stated, that, to judge from the accord of the several swings, it might be estimated at about one micron, but that the oscillations of the pendulum support introduced a constant error, seriously influencing the accuracy of the result; the *direct* measure of the motion of the support entering the result being only a fortieth of the correction to pe applied. By this method the accuracy is estimated at .01 mm. The proposition by Cellerier to swing successively on the same stand two pendulums of the same form and construction, but of very unequal weight, promises complete success towards correcting the defect in question; and the experiment is now being carried out. The second session was chiefly occupied with the reading of reports, and with a discussion respecting the value of the prismatic transit instrument. Six of these instruments employed in the Italian survey gave entire satisfaction, especially with regard to perfection of their images. The dis-

[1] Published in *Astronomische nachrichten*, no. 2451.

cussion was continued in the next session with remarks about the greater variability of the error of collimation in the prismatic transit; but its superiority in its low Y's over the common form of the instrument was recognized. In connection with the pendulum of reversion, Hirsch refers to the observations of Mr. C. S. Peirce of the U. S. coast and geodetic survey, at Geneva, Berlin, and Hoboken in America, which prove experimentally the theoretical conclusion of the complete elimination of the resistance of the air by the use of Bessel's pendulum of reversion, — a conclusion indorsed by Ferrero from experiments made in Italy. In the fourth session, Villarceau explains the construction of his new apparatus for the relative measure of the intensity of gravity, and the commission recommends a direct comparison of the new apparatus and of the apparatus of Cellerier at a number of stations. A discussion followed on self-registering tide-gauges and river-gauges; Mr. Diesen stating, that in Holland as many as sixty-four instruments were in operation, or being put to immediate use. Professor Nagel was elected a member of the permanent commission. In the following session the business programme for the seventh general conference of the European association for the measurement of arcs was formulated and adopted: viz., —

1. Reading of the annual report of the permanent commission.

2. Reports of the progress of geodesy by the representatives of the several countries.

3. Reviews of the present state of geodetic operations, subdivided as follows: —

Astronomical longitudes, latitudes, and azimuths (reporter, Backhuyzen); Triangulations (reporter, Ferrero); Base-lines and base-apparatus (reporter, Perrier); Levels of precision (reporter, Hirsch); Tide-gauges (reporter, Ibañez); Gravity apparatus (reporter, von Oppolzer); Refraction (reporter, von Bauernfeind); Geodetic publications (reporter, Baeyer); Arc of the parallel in Europe (reporter, Faye).

The proposition to meet at Rome in October next is adopted, pending the favorable acceptation by the Italian government.

The remaining part of the pamphlet is occupied with reports in detail of the progress made during the years 1881–82 in the countries represented. Their contents may be briefly summarized as follows: —

Baden, Germany. — Levels of precision, and publication of the results of the Rhenish triangulation.

Bavaria, Germany. — Observations of terrestrial refraction, lateral and vertical; spirit-levelling, total development to date 2,578 km.; oscillations of the ground, and pendulum observations at the Bogenhausen observatory.

Denmark. — The fourth volume of the geodetic survey is promised towards the close of 1883.

France. — Connection by new triangulation of the base-lines of Melun and of Perpignan; extension of the Algerian arc of the parallel into Tunis; measures of latitudes and of differences of longitude by telegraph. Volume xii. of the 'Mémorial du dépôt de la guerre' is in press, and a table of logarithms of eight places of decimals is in preparation.

Hesse, Germany. — Levels of precision, mean error per km. equals 2.27 mm., from 32 differences in levels, connected by 14 conditional equations.

Holland. — Connection of lines of spirit-levellings with lines of adjacent countries; total length levelled, 283 km.

Italy. — The reconnaissance for the primary and secondary triangulation completed; geodetic levelling and tidal observations; determination of a latitude, an azimuth, and of several differences of longitude, by telegraph; comparative pendulum observations at Rome.

Austria. — Measure of astronomical latitudes; telegraphic determinations of differences of longitude; pendulum experiments; triangulations and astronomical work in general; occupation of points, and attempts of measures of angles, in the high Alps (among these Ankogl at an elevation of 3,263 m.; station Grossvenediger, of 3,659 m.; and of Grossglockner, of 3,798 m.); extension of triangulations in Bosnia, Herzegovina, and Dalmatia; continuation of levelling operations in Austria proper, and in Hungary; observations of the intensity of gravity in the deep mine of Pribram. The work executed in this country is too extended and diversified to be given here in detail: it is graphically represented in a finely executed map in color-print.

Portugal. — Continuation of the triangulation and of tidal observations.

Prussia. — Revision and completion of principal lines of levels. The following important results are recapitulated: Atlantic higher than the Mediterranean from levels between Swinemunde on the Baltic, and Marseilles, *viâ* Switzerland, 0.664 m.; Swinemunde to the Mediterranean, *viâ* Amsterdam and Ostend, 0.658 m.; and Santander to Alicante, in Spain, 0.662 m. The discussion of the tidal observations at Swinemunde showed no change in the relation of land and water during fifty-four years, and the mean level of the Baltic results with a probable error of ±6.1 mm. The levellings to Constance and to Amsterdam are published, and the mean level of the North Sea is found 9.3 cm. above that of the Baltic. Computation of polar co-ordinates between geodetic and astronomical points. Determination of latitudes and azimuths. Maximum local deflection of the vertical reaches 6″.1 in the meridian, and 12″.7 in azimuth.

Roumania. — Astronomical determinations of positions.

Russia. — Connection of the triangulation of Bulgaria with that of Russia; astronomical determination of differences of longitude, connecting Bulgaria with Pulkowa, and Tiflis with the triangulation of the Caucasus; pendulum observations continued in the Caucasus; extension of the levels of precision (double measures) up to date, 4,123 km., and of single lines 618 km.

Saxony, Germany. — Publication of part i. of the third section of the astronomical and geodetic observations, comprising ten stations; recomputation of the base at Grossenhain.

Switzerland. — Additions to the triangulations to connect astronomically determined positions, and two new base-lines at Weinfelden (length 2.5 km.) and at Bellinzona (length 3.2 km.), both measured with the Spanish apparatus of Ibañez; mean error of measure, $\frac{1}{6000000}$ for the Aarberg base of 1880, $\frac{1}{3000000}$ and $\frac{1}{9000000}$ for the other two bases respectively. The coefficient of expansion of the iron bar of this apparatus had increased during twenty years $\frac{1}{13}$ part. After sixteen years of labor, the operations of levels of precision have been brought to a close.

Spain. — Determination of the length of the triangle side, Mulhacen-Tetica (82827.546 m. ±0.115 m.), of the great quadrilateral connecting Spain with Algeria; adjustment of the triangulation connected with the base of Olite; junction of the Balearic Islands with the mainland, and observation of one side, of 240 km. in length (Desierto to Torrellas), during the night, by means of electric light; tidal and levelling operations; determination of the longitude between Madrid and Badajos; gravity measures at Madrid.

Wurtemberg, Germany. — Connection of lines of spirit-levellings with levels of the Black Forest.

Belgium. — Comparison of results of the adjusted triangulation.

Norway. — Results of the difference of longitude of Christiania and Bergen, and of two base-lines with probable errors of $\frac{1}{1570000}$ and $\frac{1}{1500000}$ of their length; adjustment of a base-connection with a primary line involving fifty-three conditional equations.

In conclusion, Yvon Villarceau presents a paper on observations made at Paris with an isochronic regulator in connection with his new method for relative measures of gravity; the apparatus, however, had not yet been brought to the desired perfection. C. A. S.

TRYON'S CONCHOLOGY.

Structural and systematic conchology (etc.). By GEORGE W. TRYON, Jun. Vol. ii. Philadelphia, *the author*, 1883. 430 p., 69 pl. 8°.

THE second volume of Mr. Tryon's work has appeared with commendable promptness. It contains a discussion of the Cephalopoda, Pteropoda, and the Gastropoda, beginning with the pectinibranchs, as far as and including the nudibranchs. The classification is, of course, the same as that criticised by us in the first volume, and cannot be said to improve on closer acquaintance. Some of the allocations seem particularly inadvisable. For instance: Scissurella, usually regarded as of family rank, is combined without reserve with Pleurotomaria in one family. The Bellerophontidae are retained in full family rank; and yet they are with great probability, as suggested by Meek, only large, symmetrically rolled Emarginulas, which latter are put in a different suborder, with the true Limpets, to which they have no close relation, and divorced from the Haliotidae, which they more nearly resemble.

The order Polyplacophora is defined (p. 103) as having the "shell multivalve, consisting of eight pieces inserted upon the back of the animal, and surrounded by a mantle border;" yet with the Chitonidae are placed, to form this order, a family Neomeniidae, which, to say nothing of other differences, have no shell at all.

The order Pectinibranchiata is defined as having pectiniform branchiae in a cavity above the neck, 'having an external opening upon the side of the neck,' dioecious, and with spiral shells.

The order Scutibranchiata is described as having pectiniform branchiae in a cavity above the neck, *or at the lower edge of the mantle around the foot*, dioecious; shell spiral *or conical*, holostomate.

The portions in italics are intended to cover the Docoglossa, which do not belong with the

Scutibranchs at all, in our opinion. Excluding these, which refer only to the Docoglossa, it will be observed that the only difference (according to the definitions) between the two orders is, that the latter has a holostomate shell. Everybody knows that a large proportion of the pectinibranchs of Tryon are holostomate, that is, have an entire aperture without a canal: for instance, Scalaria, Cyclostoma, Litorina, etc. What, then, becomes of the two orders? As a rule, the definitions are deficient in not giving essential characters, even when the groups defined are perfectly valid, and redundant in giving characters belonging to groups of different rank from the one defined, or of no particular value.

Of small errors we have noted not a few; but it is probable that a book of this kind must be expected to have a certain number, and completeness can hardly be looked for. However, the author has brought together an immense number of genera; and the work, when the index appears, will be very useful to conchologists on this account, though it would have been more so, had each genus been given a date, since, in general, there are no references. The coloration of the plates, also, is better than in the previous volume, and the figures for their kind are fairly good. The work is well bound and on good paper, but suffers from inferior printer's ink, which 'overlays' on nearly every page.

In conclusion we may say, that, for use as a text-book for fresh students, this work would be decidedly inadvisable; but those who have already gained some knowledge of modern classification, and of the anatomy and physiology of mollusks, will find it to a certain extent useful, though by no means to a degree commensurate with the labor which has evidently been spent upon it.

ADAMS'S LECTURE ON EVOLUTION.

Evolution: a summary of evidence. A lecture delivered in Montreal, March, 1883, by Robert C. Adams. New York, *G. P. Putnam's Sons*, 1883. 44 p. 12°.

Mr. Adams has attempted to summarize in a single lecture the various kinds of evidence that have been adduced in favor of the evolution of plants and animals, and the earth itself. The author claims to be nothing further than a compiler, and aims to present 'an abstract of many books' in 'plain language.' As he has not limited himself to any particular class of evidence, nor confined his attention to any single object, or group of objects, it is obvious that any attempt to treat in a single lecture the wide range of subjects embraced under evolution must prove a failure. It is simply a jumble of facts, collected, for the most part, from popular books and essays, with a considerable admixture of error and misconception. A little familiarity with the more recent discussions on the subject of the origin of the vertebrates (for example, those of Dohrn and Lankester) would have led our author to very different views concerning 'the connecting links' between vertebrates and invertebrates, and saved him the trouble of rehearsing exploded ideas respecting Amphioxus and the ascidians. Any respectable text-book in systematic zoölogy would have told Mr. Adams that an ascidian is not a mollusk, that Balanoglossus is not regarded as an 'intermediate form' between mollusks and such 'jointed animals' as crustaceans and insects, and that corals are not protozoa.

The author's reference to intermediate forms and 'connecting links' shows that he has not grasped the ideas now generally received concerning the genealogical relationship of animals. One or two passages will illustrate this point. "If in twenty-one days the chick passes through the forms common to sponges, shell-fish, fish, and reptiles, does it not suggest that its race may have developed through these lower races during vast ages? If in forty weeks a single man now develops through forms common to all the lower races of animals, may not the race of man have slowly arisen through all the ranks of life below him, each great division leaving its record in the unfolding germ of the latest individual? . . . Through the sponges we find the radiates connected with the protozoans, or first forms of life, such as corals and sea-animalcules."

Under the head of 'Unity of substance' we are told that "the germs which produce men, dogs, sheep, or any of the highest class of animals, cannot be discovered to differ by any test of microscope or chemistry. . . . Each individual begins life in the lowest form of matter, and develops through forms common to all the species below it. A man has by turns the forms of the germs of plant, protozoan, mollusk, articulate, and vertebrate — fish, reptile, and mammal."

The lecture abounds in such loose and inaccurate statements as the above, and must therefore be pronounced an unsafe guide to 'the uninitiated,' to whom the lecture is especially addressed.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Rings of Saturn. — Mr. William B. Taylor recalls attention to the announcement made by Otto Struve in 1851, that the observations of two hundred years showed the rings of Saturn to be widening, and the inner edge of the inner bright ring to be approaching the body of the planet. Later observations tend in the same direction; and, though there may have been unintentional exaggeration in Struve's numerical results, there seems little reason to question the general fact.

Accepting the only tenable theory of the rings, — that they are composed of discrete particles, each revolving in its own orbit, — we may, by Kepler's law, compute the period of rotation of any part of the ring. Assuming the period of the inner satellite (Mimas) to be 22 h. 37½ m., the computed period of the outer edge of the ring is 14 h. 30 m.; of the dividing-stripe, 11 h. 20 m.; of the inner edge of the bright ring, 7 h. 12 m.; of the inner edge of the dusky ring, 5 h. 45 m.; and of the ring as a whole (supposed solid), about 10 h. 50 m. The period of the planet is 10 h. 14 m.

With the complex perturbations induced by the exterior satellites, it is evident that no particle of the ring can revolve in a circular orbit; and it follows, that, in a space so crowded with particles as to give a continuous light, there must be much interference. Whether the collisions at intercepting orbits result in heat or in disintegration, they necessarily tend to a degradation of motion, and hence to a shortening mean radius-vector and a diminishing period.

It thus appears that Struve's conclusions, based on observation, have a rational theoretic basis. The rings are falling toward the planet, and will eventually be absorbed. Indeed, on the generally received meteoric theory of their constitution, it is impossible to regard their present condition otherwise than as an evanescent phase of a progressive evolution.

Mr. Taylor points out that the relation between the rotation periods of the planet and the ring, and the relation between the rotation periods of Mars and its satellites, not only fail to impeach the nebular hypothesis, as some have supposed, but even fail to be anomalous.

If the planet had a velocity of rotation equal to that of a satellite revolving at its surface, it could not approach the spherical shape. And, the concrete form having once been assumed, the rate of rotation must necessarily and continuously diminish through the influence of solar tides, until eventually the planetary day and year are identical. — (*Phil. soc. Washington; meeting* Oct. 13, 1883.) [355

ENGINEERING.

Emery's U. S. testing-machine, Watertown arsenal, Mass. — This machine is described from general and detailed drawings furnished by the designer. The machine excels in strength, capacity, durability, accuracy, and sensitiveness. The demand is said to have been: 1°. A machine to test to 800,000 pounds, and so delicate that it would test a single horse-hair. 2°. Attachments enabling it to seize and hold uninjured, while applying such loads, all usual sizes and shapes of specimens. 3°. Safety against injury by shocks of recoil. 4°. Accessibility of samples and straining parts, while in operation, for purposes of measurement and inspection. 5°. Small cost of operation.

The machine was tested, when finished, to 1,000,000 pounds, and under smaller loads, ranging down to a single horse-hair, with success; and was accepted by the U.S. board appointed to test iron, steel, and other metals. The loads are applied by a hydraulic press; and the weighing is done through reducing-pressure cushions and water-columns terminating at a point of connection with weigh-beams without knife-edges and having extraordinary sensitiveness. Mr. Emery is constructing smaller machines, and scales and pressure gauges involving the nicer and more remarkable devices introduced in the large machine, at the works of the Yale & Towne company, at Stamford, Conn. Mr. Emery's inventions are expected to aid effectively in securing a more exact knowledge of the properties of the materials of construction, and of their value in structures. — (*Amer. mach.*, July 21.) R. H. T. [356

Engineering of the great statue of Liberty. — Mr. Ch. Talausier describes the details of engineering involved in the design of Bartholdi's statue of 'Liberty enlightening the world.' The plan was conceived by M. Bartholdi in 1871, while *en voyage* for the United States. On the hundredth anniversary of the declaration of independence, France offered the great statue to the United States. It was accepted, is now nearly completed, and preparations for its erection on Bedloe's Island, in New York harbor, are being made. The statue is of copper. carried and strengthened by an inner skeleton of iron, One arm, carrying the torch, was sent to the Centennial exhibition at Philadelphia in 1876, and has since been on exhibition in New York. The sculptor first made a model 2.11 m. high, which was then copied on a fourfold scale; and the statue was constructed from this model in sections by similarly enlarging each section. For each piece, a 'centre,' or mould, was made of wood, on which the copper could be worked and fitted. The sheet-copper epidermis of the statue is composed of 300 pieces, and weighs 80,000 kilograms (178,000 lbs.). The iron frame weighs 120,000 kilograms (264,000 lbs.). When finally erected, the sheets of copper will be riveted together with copper rivets 5 mm. in diameter (0.2 in.), and spaces 25 mm. (1 in.) apart. The iron skeleton is to be secured to the foundation at four points by 12 foundation-bolts 0.15 m. (6 in.) in diameter, and extending 15 m. (49.7 ft.) into the masonry. The variation of form and dimensions, with varying temperature, is provided against by the elasticity of every part; and corrosive action is to be checked by painting with red lead all points of contact of iron and copper. The height of the statue is 46 m. (150.9 ft.) from base to top of its torch, and 34 m. (111.5 ft.) to the top of the head. The index-finger is 2.45 m. (8.04 ft.) long, the eye is 0.65 m. (2.2 ft.) in diameter, and the nose is 1.12 m. (3.67 ft.) long. A dinner of 26 covers has been given in the trunk of the statue. The total weight will be 200,000 kilograms (440,000 lbs.). The granite pedestal will be 25 m. (82 ft.) high, and the cost of the whole not far from 1,200,000 francs ($240,000 nearly). The maximum pressure of the wind on the surface of the statue is reckoned at 87,000 kilograms (191,400 lbs.). —(*Le génie civil*, Aug. 1.) R. H. T. [357.

METALLURGY.

The basic process at Peine works, Germany — All difficulties at these works are said to have been overcome, and phosphoric pig is being made into Bessemer steel.

Analyses of the steel vary as follows:—

	1	2
Manganese	0.47	0.30
Phosphorus	0.06	0.02
Sulphur	0.06	0.03
Carbon	0.14	0.09

The cinder yields the following analysis:—

Silica	2.45
Ferric oxide	5.74
Ferrous oxide	15.10
Manganous oxide	2.75
Alumina	2.85
Lime	46.82
Magnesia	1.14
Phosphoric acid	22.23
Sulphuric acid	0.38
Sulphur	0.54

The Ilsede pig used in the above works contains 2.5 % to 3.1 % phosphorus. The walls of the converter stand 80 to 95 blows; the bottoms, 16 to 24 blows. — (*Eng. min. journ.*, July 14.) R. H. R. [358

Copper production of the world. — Messrs. Henry Merton & Co. of London have compiled statistics of production of copper in tons, from which the following figures are selected:—

	1879.	1880.	1881.	1882.
Chili	49,318	42,916	37,989	42,909
United States	23,350	25,010	30,882	39,300
Spain and Portugal	12,751	14,559	15,693	15,893
Germany	9,976	11,776	13,718	14,235
Australia	9,500	9,700	10,000	8,950
England	3,462	3,662	3,875	3,875
All other countries	39,299	41,278	45,981	46,451
Totals	147,656	148,901	158,138	171,613

The figures are claimed to have been compiled with great care. — (*Ibid.*, July 14.) R. H. R. [359

AGRICULTURE.

Manuring with potash salts. — In a large number of experiments in which potash salts (sulphate and chloride) were applied in the spring, and within three days of the time of sowing, Farsky found the effect to be a decrease of the crop. It is evident, from the author's statements, that the salts were applied in too large quantity in the immediate neighborhood of the seed. Experiments with the crude Stassfurt salts gave more favorable results in many cases. Potassium chloride gave, in most of the trials, better results than the sulphate, and fall manuring better than spring. The effect in the second year was often better than that in the first. — (*Biedermann's centr.-blatt.*, xii. 459.) H. P. A. [360

Manuring oats. — An extensive series of experiments by Beseler and Märcker gave the following interesting results:—

Manuring with phosphoric acid alone produced no notable increase of the total crop or of the grain. Manuring with nitrogen alone, in the form of nitrate of soda, gave an increase of crop roughly proportional to the amount of nitrogen applied. With a light manuring of nitrogen, addition of phosphoric acid produced a further increase of crop: with a heavy manuring of nitrogen this was not the case.

Manuring with phosphoric acid alone did not increase the percentage of proteine in the grain. Manuring with nitrogen alone increased the proteine, but diminished the fat. Addition of phosphoric acid to the nitrogenous manure restored the fat to its original amount, or even raised it above that point. The quality of the grain was best when the total amount of the crop was greatest. In these experiments the total nitrogen of the crops equalled about fifty-five per cent of the amount applied as manure. — (*Ibid.*, xii. 472.) H. P. A. [361

GEOLOGY.

Synchronism of geological formations. — Professor A. Heilprin called attention to Prof. Huxley's conclusions, that, 1°, formations exhibiting the same faunal facies may belong to two or more very distinct periods of the geological scale as now recognized, and, conversely, formations whose faunal elements are quite distinct may be absolutely contemporaneous; and that, 2°, granting this disparity of age between closely related faunas, all evidence as to the uniformity of physical conditions over the surface of the earth during the same geological period falls to the ground. Prof. Heilprin maintained that it can be readily shown by a logical deduction that the first conclusion is almost certainly erroneous, and that the second derives no confirmation from the supposed facts. If, as is contended, several distinct faunas, or faunas characteristic of distinct geological epochs, may have existed contemporaneously, then evidences of inversion in the order of deposit ought to be common, or, at any rate, they ought to be indicated somewhere; since it can scarcely be conceived that animals everywhere would have observed the same order or direction in their migrations. Why has it so happened that a fauna characteristic of a given period has *invariably* succeeded one which, when the two are in superposition all over the world (as far as we are aware), indicates precedence in creation or origination, and never one that can be shown to be of later birth? Surely these peculiarities cannot be accounted for on the doctrine of a fortuitous migration. Nor can it be claimed, that, through the interaction of the evolutionary forces, a migrating fauna with an early-life facies will in each case, at the point of its arrest, have assumed the character of the later-day fauna which belongs to that position. Therefore it appears inexplicable that a very great period of time could have intervened between the deposition of the fauna of one great geological epoch at one locality, and that of the same or similar fauna at another locality distantly removed from the first. In other words, the migrations — for such must undoubtedly have been the means of the distant propagation of identical or very closely related life-forms (unless we admit the seemingly untenable hypothesis that equivalent life-forms may have been very largely developed from independent and very dissimilar lines of ancestry) — must have been much more rapidly performed than has generally been admitted. What applies to the broader divisions of the geological scale also applies to the minor. Thus the subordinate groups of a formation are almost as definitely marked off in the same order, the world over, as are the formations themselves. After breaks in formations, the appearance of characteristic fossils is largely the same; whereas, on the theory of synchronism of distinct faunas, such a succession would certainly not be constant. The opinion held by the older geologists was therefore probably correct; namely, that formations characterized by the same or very nearly related faunas in widely separated regions belong, in very moderate limits, to approximately the same actual age, and are to all intents and purposes synchronous or contemporaneous. —(*Acad. nat. sc. Philad.; meeting* Oct. 2, 1883.) [362

METEOROLOGY.

Tornado studies. — A study of the tornado of June 7, 1882, in the valley of Säby, has been made by Fineman. It embraces investigations upon the course of this tornado, and the accompanying atmospheric conditions, which are not different from those pointed out by Finley in the case of tornadoes in the United States, and includes a general investigation of the theory of tornadoes, with references to the work of other authors in this field of inquiry. The author refers to the combination of great humidity, high temperature, and absence of wind, as the special condition of tornado formation, and investigates the characteristic phenomena shown in its progress. He further discusses the relation of tornadoes and thunder-storms, and urges increased study in solar radiation and the gyratory motion of fluids, in order to throw light upon this and other meteorological investigations. — (*Sur la Trombe*, June 7.) W. U. [363

Notes. — The annual re-union of the council of the meteorological bureau of France was held in March. The leading discussions related to observations in agricultural meteorology, the securing of reports of thunder-storms and rainfall statistics, and the transmission of telegraphic messages in the interest of the science (*Ann. soc. met.*, March, 1883). —— A valuable contribution to our knowledge of the surface-temperatures of the Atlantic along the coasts of Portugal, Senegambia, and Brazil, has been made by M. Hautreux from the observations taken on the steamers which traverse this region (*Ann. hydr.*, viii. 1883). —— The *Zeitschrift* for August contains a number of climatological articles, discussing observations made at Stuttgart, Frankfort, Lyons, Puebla, Guadalajara, and in southern Brazil. —— The *Annuaire* for May contains a contribution to the study of the climate of central Africa, by M. Angot, from observations, which are rather fragmentary, made at three missionary stations, mostly in 1881. —— Rev. Clement Ley is preparing a work upon the observation of clouds. The international committee, at its meeting in 1882, appointed a committee, consisting of Messrs. de Brito Capello, Clement Ley, and Hildebrandsson, to draw up a scheme of instructions for the observation of cirrus-clouds. —— Dr. Selah Merrill, U. S. consul at Jerusalem, has submitted to the State department a report upon the climate of Palestine, based upon observations covering a period of twenty-two years. An extract is published in the August Weather review of the signal-office. — W. W. [364

GEOGRAPHY.

(*Arctic.*)

Arctic notes. — The Austrian Jan Mayen expedition arrived at Vienna, Aug. 22, and were received with public festivities. No illness had occurred during their stay on the island. The observations taken are satisfactory. Rich collections have been made, and numerous photographs taken. —— The latest news from the English party under Capt. Dawson, at Fort Rae in the North-west Territory, is favorable, and observations were going on with regularity. Spectroscopic observations of the aurora borealis have been very satisfactory, though the phenomena have not been particularly brilliant. —— Satisfactory accounts have also been received of the work done by the Swedish expedition to Spitzbergen, which has returned without loss or accident. —— Reliable information has at last been received from the Schieffelin party, on the Yukon, near its junction with the Tananah River. They have returned to San Francisco all well. Gold had been discovered twelve miles up from its mouth, on a small river falling into the Yukon. The bed-rock was slate, and the gold found was in smooth washed particles in loose gravel. Winter setting in prevented further search, and the season was found to be too short for satisfactory results in placer mining. Mr. Schieffelin warns prospectors against coming rashly into the country, unprovided with supplies and tools, as nothing suitable for prospecting work can be had there. —— Later reports from the Arctic Ocean north from Bering Strait give little improvement in the conditions or catch of the whaling-fleet over previous advices. The whalers were anticipating better luck toward the end of the season. —— A button and coin obtained at Cape Prince of Wales, from the natives, about a year ago, have been forwarded to the Navy department in the idea that they might be relics of

Putnam, who was lost on the ice during the Jeannette search. They were said to have come from the body of a drowned white man. The natives of this region are fond of inventing such stories, especially since the search expeditions, as they suppose they will be paid for them. Navy brass buttons have been an article of trade on this coast for many years. The fact that Putnam had no such buttons on his clothing when lost, settles the case in regard to these particular objects. —— Bove discusses in the bulletin of the Italian geographical society the meteorological observations made on board the Vega during her voyage in Siberian seas. His article is a *résumé* of the work of Hildebrandsson, elsewhere published. —— In the Bulletin of the *Paris société de géographie*, A. Bellot summarizes the history of the Jeannette expedition, and the distribution of the international polar stations. His paper is accompanied by a map. — W. H. D. [365

(*Asia.*)

Population of Japan. — The last census (January, 1883) gives a total population of 36,700,118 souls, nearly equally divided between the sexes, the males being about one per cent in excess. Kioto, the imperial city, contains 709,000, and Tokio, the capital, 1,064,000 inhabitants in round numbers. — (*Bull. soc. géogr. Mars.*, June.) W. H. D. [366

Petroleum in the Caucasus. — According to the British vice-consul at Batum, Mr. Peacock, the oil-region of the Caucasus covers some 1,200 square miles. The most productive locality is the Apcheron peninsula, where the wells far exceed those of Pennsylvania. The total production has risen from 500,000 barrels in 1873, to about 4,000,000 barrels in 1881. The export from Baku has increased at the rate of 1,250,000 barrels in two years. According to the daily papers, a pipe-line is projected from the oil-region to Baku; and the American producer must rely on the quality of his product, rather than on its cheapness, for the future of our export trade. — (*Brit. cons. rep.*, 1882.) W. H. D. [367

BOTANY.

Observations on yeast fungi. — The fifth part of Brefeld's '*Botanische untersuchungen*' forms a volume of over two hundred pages, with thirteen quarto plates, and treats of the development of the Ustilagineae. The author considers principally the germination of different species of Ustilago, Thecaphora, Geminella, and Tilletia; and, besides sowing the spores in water, he sowed them in nutritive fluids, and by this means was able to get more luxuriant growths than other students of this order of fungi. The germination of the different species may be classed under two different types. In the one, a short promycelium is given off by the spore, and the sporidia are borne laterally; while, in the second type, a whorl of cells is borne at the tip of the promycelium. By using nutritive fluids instead of water, Brefeld was able not only to obtain luxuriant growths of sporidia, but also to keep them alive for several months, or even a year. He believes that the sporidia are merely conidia, and in his cultures they produced fresh crops of conidia for an indefinite period. He further considers that the so-called conjugation of the secondary cells of species belonging to the second type, as Tilletia, is not a sexual process at all, but merely a fusion such as exists in other orders of fungi. When cultivated in nutritive fluids, the whorls of secondary cells do not conjugate or fuse, but produce conidia directly; while in water, which is not favorable to further growth, a fusion takes place. He calls the conidia 'hefe,' from their resemblance to the forms of Saccharomycetes; the difference being, that in one case, although the yeast-like form can be made to propagate itself in fluids indefinitely, we know that it came originally from some species of Ustilagineae, whereas, in the other case, illustrated by the beer ferment, we cannot tell of what form it was originally the conidia. He refers to other hefe-forms in the Hymenomycetes and Ascomycetes. In *Exoascus aureus* he states that the polysporic condition of the so-called asci is nothing more than a hefe-like growth of a few round spores within the ascus. In short, he believes that all yeast-like forms are merely conidia, and denies the autonomy of the Saccharomycetes; nor does he believe that they are closely related to the Ascomycetes. — W. G. F. [368

Insect fungi. — Hoffmann figures an interesting branched variety of the rare Torrubia cinerea Tul., on an adult Carabus from Germany, under the name of var. brachiata. The typical form occurs on Carabid larvae. — (*Flora*, Aug. 21.) W. T. [369

ZOÖLOGY.

Mollusks.

Landshells of Gibraltar. — Kobelt reports, that the fauna of the Rock of Gibraltar is very peculiar, many characteristic species of the Mediterranean being wanting. The genus Leucochroa, for instance, is represented neither in Gibraltar nor on the opposite coast of Morocco. Certain species of Cyclostoma and Pomatias are equally absent from both shores. Twenty species of landshells, including three undescribed species and two new varieties, were obtained on the Rock in May, 1881; but it is supposed that this is a more or less incomplete exhibit, the season of the year being not the most favorable. The locality is peculiarly interesting on account of its intermediate position between Spain and Morocco. The sea-fauna of the Bay of Gibraltar is also very rich, and contains many rare or peculiar forms. — (*Journ. conch.*, iv. no. 1.) W. H. D. [370

Absorption of the shell in Auriculidae. — Crosse and Fischer illustrate and describe the peculiar absorption of the inner parts of the upper whorls of the shell in this family, and also in the genus Olivella. These animals appear to have the power of dissolving entirely the internal partitions of the shell, from a point some distance inside the aperture to the very apex. The only exception in the family Auriculidae is the genus Pedipes, in which the partitions were found intact. The absorption is not always complete, nor are the same parts invariably missing. Complete absorption was observed in Melampus, Auricula, Blauneria, Marinula, Tralia, Alexia, Monica, Plecotrema; only partial absorption in Cassidula and Scarabus. The case of Olivella is more remarkable; since the allied groups Oliva, Ancillaria, etc., do not, according to the authors, present this peculiarity at all. — (*Journ. de conchyl.*, xxii. 3.) Tryon, however, observes that in Oliva reticularis he has found the walls absorbed away, so that very little of the substance remained, and considers it probable that all shells with close volutions are in the habit of absorbing them internally. It is certainly the case with many of them. — (*Man. conch. Olivella*, p. 64.) W. H. D. [371

Crustaceans.

Anatomy of the spider-crab, Libinia. — E. A. Andrews gives a very careful description, illustrated with three excellent photolithographic plates, of the anatomy of Libinia emarginata, the common spider-crab of the eastern coast of the United States. The paper, which was originally presented as a graduation thesis for the bachelor's degree in the Sheffield scientific school, describes fully the structure of the body-walls, appendages, and the alimentary, circulatory, nervous, and reproductive systems. The structure throughout agrees very closely with that of Maia squinado of Europe. Mr. Andrews's work will be found a very useful guide for American students, as it is the only description thus far published of the whole anatomy of any American brachyuran. — (*Trans. Conn. acad.*, vi., Aug., 1883.) S. I. S. [372

A new host for Cirolana concharum Harger. — Rev. Samuel Lockwood announced the discovery of this isopod in the interior of the edible crab, Callinectes hastatus Ordway. The crab was an adult female, and the parasites were crowded in the left side of the carapace. Incredible to say, there were twenty-three full-grown specimens, measuring three-fourths of an inch by about a quarter of an inch each. The ovaries and the tissues on the left side were completely honeycombed. How long the animal could have lived, and what its real sufferance of pain was, are questions. But with these predaceous wolves, literally consuming its inwards, it surely would soon succumb. It seemed to Mr. Lockwood that they must, when in the swimming larval state, have entered near the eye-stalks of the crab, which, with a large catch of others, was taken at the close of February in Raritan Bay, New Jersey. From the size of the parasites, it would seem they had been in possession some three months. The determination of the isopods was due to the kindness of Mr. Oscar Harger. The query how so large a number could have entered the same place, and at the same time, he thought was met by the supposition that the crab had found a nest of the larvae, and was feeding on them, when a part of the batch entered the host, as conjectured above. — (*New Jersey st. micr. soc.; meeting* March 19.) [373

Arachnids.

Restoration of limbs in Tarantula. — Rev. Henry C. McCook remarked that a tarantula exhibited to the meeting had been kept in confinement nearly a year, fed during winter on raw beef, and in summer on grasshoppers. In the spring it cast its skin by a laborious process, in the course of which it lost one foot and two entire legs. This summer again, during the latter part of August, the animal moulted. The moult as exhibited is a perfect cast of the large spider, — skin, spines, claws, the most delicate hairs all showing, and their corresponding originals appearing bright and clean. The moulting occurred during Dr. McCook's absence, but was just finished when he returned. When the cast-off skin was removed, it showed, as might be supposed, the dissevered members to be lacking. On looking at the spider itself, however, it was seen that new limbs had appeared, perfect in shape, but somewhat smaller than the corresponding ones on the opposite side of the body. The dissevered foot was also restored. The loss of the opportunity to see the manner in which the legs were restored during moult was greatly regretted, but we have some clew from the careful and interesting studies of Mr. Blackwall. Several spiders whose members had been previously amputated were killed and dissected immediately before moulting. In one of these the leg, which was reproduced, was found to have its tarsal and metatarsal joints folded in the undetached half of the integument of the old tibia. Another like experiment was made with an example of Tegenaria civilis. The reproduced leg was found complete in its organization, although an inch in length, and was curiously folded in the integument of the old coxa, which measured only one-twenty-fourth of an inch in length. Dr. McCook's tarantula had lost both legs close to the coxae; and in the moult the hard skin formed upon the amputated trunks was wholly unbroken, showing that the skin had been cast before the new leg appeared. We risk nothing in inferring, that, as in the case of Blackwall's Tegenaria, the rudimentary legs were folded up within the coxae, and appeared at once after the moulting, rapidly filling out in a manner somewhat analogous to the expansion of the wings in insects after emerging. — (*Acad. nat. sc. Philad.; meeting* Sept. 25.) [374

VERTEBRATES.

Birds.

Anatomy of the Passeres. — Mr. Forbes finds the syrinx, as well as all other points examined, of Orthonyx spinicauda and O. ochreocephala, to be strictly oscinine. The carotid of the first is peculiar in that it accompanies the vagus nerve instead of running in the hypophysial canal. On anatomical grounds, O. ochreocephala is separated from the Australian form as Cletonyx of Reichenbach. Contrary to Prof. Parker, Mr. Forbes finds a perfectly oscinine syrinx in Petrocca. — (*Proc. zoöl. soc. Lond.*, 1882, 544.) J. A. J. [375

Respiratory organs of Apteryx. — Under this title, Prof. Huxley gives a succinct account of the lungs and air-sacs as typically found in birds, and notes that the respiratory organs are separated by an oblique septum from the cardio-abdominal cavity, as in the crocodiles. The lungs of Apteryx are strictly avian, in no wise mammalian, though poorly developed. Prof. Huxley considers them to show a fundamental resemblance to those of crocodiles The introduction of so many new terms is to be regretted. — (*Proc. zoöl. soc. Lond.*, 1882, 560.) J. A. J. [376

ANTHROPOLOGY.

Indian courtship. — Mrs. H. S. Baird recites a bit of her own observation respecting Indian courtship half a century ago in Wisconsin. When a youth falls in love, he places himself a little way from the maiden's wigwam, wearing one blue and one red legging. He then plays in a minor strain an air upon the flute, pib-pi-gwan. If he is permitted to proceed, he knows that there are no objections to his addressing the loved one. If the parents have objections to him, he is informed that he is too noisy, etc. In the latter case he discontinues his serenades: in the former the flute-playing gives place to visits, the father saluting, and saying. 'Come in, friend: there is room for you;' upon which all the family give a sort of hitch up, to make room for one more around the fire. The young man seats himself by the door, and next to the daughter; as the eldest son and daughter always sit nearest the door, on each side of it. The lover then produces a few small pine sticks, one of which he lights at the fire, and hands to the maiden. If she takes it, he is accepted: if she does not, but lets him hold it until it goes out, he is rejected. When the time arrives for them to be united, the parents of the young man bring valuable presents, such as furs, while the parents of the bride bring ornamental work. These are distributed among the friends. The bride is dressed by her sister-in-law. and conducted to her place in the wigwam to await alone the coming of her husband. In other cases, when father-right prevails, she goes to his home. A man can have as many wives as may be required to dress his game and carry it home. — (*Wisc. hist. soc.*, ix. 311.) J. W. P. [377

The mounds of Wisconsin. — If one wishes to keep himself informed upon archeology, he must not neglect the volumes of the state historical societies. The Rev. Stephen D. Peet has done a good service, with reference to the emblematical mounds in Wisconsin, by presenting in a condensed form not only the description of the structures, but also the names of the most important works in which references to them may be found. Mr. Peet is well acquainted with the effigy mounds, and therefore adds many original observations, which are in the main extremely cautious. Attention is directed to the difficulty of determining the shape of the mounds, by reason of deformations due to the plough, the tramping of cattle, the wear of the elements, the avarice of relic-hunters, and the encroachments of the modern architect. Again: many of the animals once common have departed from this region, such as the buffalo, moose, elk, antelope, bear, lynx, and wild turkey. If the mounds represented in shape the badges, weapons, and symbols of the natives, they, also, are unfamiliar.

The author ascribes to all these mounds a religious significance, in which opinion he is not warranted by what is known. His reflections upon the cross-symbol, however, are very just. As to the shapes of these structures, we have the mace, double bow, groups of cones, triangular enclosures, besides every variety of animal supposed to have lived in this region. Mr. Peet dismisses the 'elephant mound' with a modest introduction to its sponsor. — (*Wisc. hist. coll.*, ix. 40.) J. W. P. [378

Chinese not homogeneous. — Mr. E. Colborne Baber, secretary to H. M. legation, Peking, makes the following interesting statement: "The population of China is far from being so homogeneous as is generally supposed. I have often heard English people assert their inability to distinguish one Chinaman from another; but it may surprise you to hear that a Chinaman, on first coming into contact with Europeans, makes precisely the same remark of ourselves. At first they have some difficulty in even distinguishing a woman from a man. In spite of a general persistence of type, there is at least as much variation among the natives of the eighteen provinces as there is among the inhabitants of Europe. A thousand years before Christ the Chinese nation occupied a mere fraction of the territory which they now possess. Even then they were not homogeneous in manners or speech, and they were environed by many non-Chinese indigenous peoples. Since then the Chinese have spread, not by ousting or exterminating their neighbors, but by a process of absorption: in other words, they migrated among them, and intermarried with them: and their superior energy and comparative civilization gradually effaced the national characteristics of the surrounding tribes. The same process is going on in Tibet, in Burma, in the Shan country, in Tonquin, and in the Straits Settlements. The Chinese blood has been mingled with such diverse stocks as the Tatar, Turki, Tibetan, Burmese, Mon-annan, Tai, and Polynesian." The discussion of this paper by Sir Rutherford Alcock, Sir Thomas Wade, Col. Yule, and Mr. Colquhoun, is a valuable contribution to Chinese sociology. — (*Proc. geogr. soc. Lond.*, Aug.) J. W. P. [379

NOTES AND NEWS.

The Maryland oyster commission, which has in view the invention of some plan which should check the depreciation of beds belonging to the state without unduly interfering with trade, met in Baltimore recently. It was suggested that dredging be restricted in various ways, and the available grounds increased by sowing the bottom with dead oyster-shells where none now exist. In 1879 Lieut. Winslow found the average in Tangier Sound to be one oyster to 2.4 square yards. In their recent examination of the oyster area of the state, the commission found that the average of sixty-one beds examined was one living oyster to each 3.7 square yards, showing a rapid and important decrease since 1879. The commission finds, as the result of the examination of forty-six oyster-beds, that there are only 1.35 living oysters to every bushel of dredged shells. While the oysters are growing scarcer, more labor is required to get them, and the amount of dead material which has to be handled is largely increased.

— The Pons comet, now approaching the sun, may be expected to be visible to the naked eye about the first of December; but it is not likely to attain a brightness comparable with that of the conspicuous comets of the last decade, unless it shall have undergone material change since its last reappearance, in 1812. The intensity of its light will be three times greater on Nov. 21 than it was on Oct. 16; and it will increase until about the middle of January, when it may be anticipated that its light will be about equal to that of a star of the third magnitude.

— The announcement of the publication of the Berlin catalogue of zonal stars will have, according to *Nature*, the effect of postponing the publication of the French catalogue, for which a credit of four hundred thousand francs had been asked from the budget commission.

— Dr. B. A. Gould passed through London early in October, *en route* for South America. The printing of the second volume of the Cordoba zones is nearly completed (in London); and Dr. Gould's attention will soon be turned to the publication of another great work undertaken by him at the Argentine national observatory, viz., the Cordoba general catalogue of stars.

— Ensigns H. G. Dresel and A. A. Ackerman, who were detached from the National museum for duty in connection with the recent Greely relief expedition, in spite of unfavorable circumstances, succeeded in collecting some interesting zoölogical and mineralogical specimens. Among them are some of the so-called meteorites of Ovifax.

— Regarding Flamsteed and Morin, Mr. W. T. Lynn writes to the editor of the *Observatory* (August, 1883): "Probably few anecdotes in the history of astronomy are better known to general readers than that related by Flamsteed, respecting the foundation of the Royal observatory being hastened, if not occasioned, by the application of the Sieur de St. Pierre to Charles II. (through the Duchess of Portsmouth) for a reward for discovering a method of finding the longitude at sea, and Flamsteed's own decision on its impracticability until the motions of the moon and the places of the fixed stars had been determined with much greater accuracy than was then possible. But it is not easy to understand the exact meaning of one of Flamsteed's expressions to St. Pierre. He says that he told him, after first proving to him how incompetent a calculator he was, and pointing out, that, independently of this, his method was inapplicable in practice, to go to his own countryman Morin, who would instruct him in a better method than his own, and not to return to the king of England until he had done so. Of course, the general force of this recommendation was, in vulgar English, to bid him go to Jericho. But surely Flamsteed could hardly have been ignorant (though he does not refer to it) that Morin had, in 1634 (forty-one years before the application of St. Pierre to Charles II.), submitted a plan similar in principle to Cardinal Richelieu, and that a committee appointed by the latter came to the same decision as Flamsteed concerning St. Pierre's proposal; that such a method was of no practical use in the existing state of astronomical knowledge. To me, it seems exceedingly likely that St. Pierre was aware of what had taken place with regard to Morin; that, in fact, he had stolen the principle from the latter (who, although he deserves all the contempt that Mädler pours upon him for prostituting astronomy to the purposes of that mass of imposture and delusion which has robbed our science of its more appropriate name of astrology, was a good mathematician for those times), and interpreted Flamsteed's last remark into the imputation that he was in point of fact found out. Flamsteed says that he heard no more of him afterwards; but he certainly did *not* go to Morin, for the best of all reasons, — Morin having died more than eighteen years before, on the 6th of November, 1656."

— In a paper on the germ-theory of disease from a natural history point of view, before the British association, Dr. Carpenter stated that many of the existing genera and species of animals and plants were altogether uncertain; that as fresh knowledge was gained, so it was found necessary to modify our accepted views — this especially holds good with genera which have great power of adapting themselves to various circumstances, and which consequently produce numerous variations. This power of modification, the author stated, was much more marked in the lower than in the higher forms of either kingdom, and was especially found in bacteria. The author then cited the case of the germ producing small-pox, in which he stated the germ had undergone such a modification, that whereas two centuries ago the disease was very severe, and known as 'black-pox,' it now existed only as a mild disease. During the last siege of Paris, however, the conditions were such that the germ reverted to its original form, and produced the same severe disease as two centuries ago. Many facts were brought forward to confirm this view.

— In a paper by Professor Hull before the British association, upon the geological age of the North Atlantic Ocean, the author made use of three leading formations as factors in his inquiry; viz., the archean (or Laurentian), the Silurian (chiefly the lower Silurian), and the carboniferous. He considers that throughout the archean (or Laurentian), the lower Silurian, and the carboniferous epochs, the regions of North America, on the one hand, and of the British Isles and western Europe, were submerged, while a large part of the North Atlantic area existed as dry land, from the waste of which these great formations had been built up; and he urged, that, if such were the case, the doctrine of the permanency of oceans and continents, as tested by the case of the North Atlantic, falls to the ground.

— The meteorological observatory established upon the top of Ben Nevis by the Scottish meteorological society was formally opened on Oct. 17 with interesting ceremonies. A party of ninety, including many ladies, climbed the mountain, in spite of unfavorable weather; and after their return to the base, where a second meteorological station is established, a dinner, with congratulatory speeches, was given. The funds for the establishment of these observatories, £5,000, have been raised by popular subscriptions, the subscribers numbering about two thousand.

— At the meeting of the German society of natural science at Halle, on Oct. 3, a paper was read by Dr. Assman of Magdeburg, on the advisability of establishing a meteorological station on the Brocken Mountain. 'What will become of the spectre?'

— Drs. Schuchardt and Krause, of the Volkmann clinical hospital at Halle, consider that they have placed the connection between scrofula and tuberculosis beyond a doubt. Following up Koch's line of research, they have discovered the peculiar bacilli of tuberculosis to be present in several distinct forms of scrofula.

— Joseph Antoine Ferdinand Plateau, professor of physics at the University of Ghent, died at that place, Sept. 15, at the age of eighty-two years.

— The U. S. hydrographic office has published a 'List of geographical positions for the use of navigators and others,' compiled by Lieut.-Commander F. M. Green. The list is divided into seventeen sections, according to the geographical position of the places, and is confined to points on the shore or on navigable rivers.

— Dr. J. Lawrence Smith died at Louisville, Ky., on Oct. 12, in his sixty-fifth year. He was born near Charleston, S.C., and was educated at the University of Virginia and the Charleston medical college. He afterwards spent some time abroad. His first paper was published while he was in Paris. A large part of his work was in meteorology, his collection of meteorites being especially famous.

— Among the exhibits at the New-Mexico territorial fair, held at Albuquerque, Oct. 1 to 5, was a collection of antiquities from the old pueblo ruins of Arizona, by Mr. Thomas V. Keam. This gentleman has long been engaged in trade in that region, is well known to the Indians and to our national surveying-parties, and has rendered very efficient service, both as an adviser and mediator, in our negotiations with the Navajos. His exhibit was highly spoken of by the Albuquerque press.

— Dr. D. G. Brinton of Philadelphia, who was one of the vice-presidents of the congress of Americanists held in Copenhagen, and the only delegate from the United States, makes a brief report of the proceedings. In 1875 the first meeting was held at Nancy; that of 1877, at Brussels; of 1879, at Luxembourg; of 1881, at Madrid. The meeting of this year was opened in the magnificent hall of the university, in the presence of the king, the royal family, the Princess of Wales, and other dignitaries. Professor Worsall presided, and delivered the address of welcome. The discussions and papers related to paleolithic man in America, Scandinavian discoveries, the history of Columbus, native American literature, ceramics, trephiny, etc. Dr. Brinton reports that the communications were very generally of a high order, though there was enough of Prince Madoc and the pilgrimage of St. Thomas to remind the members of the humble origin of archeology.

— Messrs. Kegan Paul, Trench, & Co., of London, announce Mr. Everard im Thurm's 'Among the Indians of British Guiana,' sketches, chiefly anthropologic, from the interior.

— M. Berthelot has published the results of his researches into the nature of explosives, under the title of 'Sur la force des matières explosives d'après la thermochimie.' One portion of the book appeared as an article in the *Nouvelle revue*.

In presenting his work to the Paris académie des sciences, M. Berthelot explained that he was led to those researches by the events of 1870. The first book is on his theory of the phenomena of explosion, and especially the explosive wave, which he considers throws a new light on the subject. The second book is on the composition of explosives, and the third on their comparative power. The last is very comprehensive, and he gives numerous tables.

— Mr. William J. Fisher, U. S. signal-observer at Kadiak, has found time, in the prosecution of his duties, to collect for the National museum ethnological specimens from the following Alaskan tribes: Ugashagmint, of Ugashag River, Bristol Bay; Tanichnagminte, of Lesnoi Island, near Kodiak Island; Nanuachpachmiute, of Aliaska peninsula, near Iliamna Bay; Keiichwichmiut, at Katmai settlement, Aliaska peninsula; Kiatichmynt, near Maltshatna River, Aliaska peninsula; Tshu-attshigmjnt, around Nuchek, Hinchinbrook Island, Prince William Sound.

The editor of the Smithsonian proceedings holds up this invoice of Mr. Fisher as an example to be followed by all collectors. The excellent features are the native names of the articles, the explanation of their functions, and the location of the tribe from which each comes. There is a very grave objection, however, to the spelling of the names and the identification of the tribes. Mr. Dall and others have located many little bands of Eskimo all along the Alaskan coast. Are these the same, or different ones? If the same, why another mode of spelling; and, what is worse, why is 'mut' spelled '*mint*,' '*miute*;' 'miut,' '*mynt*;' 'mjnt,' '*mjut*,' '*mjute*,' '*mjitt*,' '*mjent*,' *mjunt*,' and '*mut*'? Strenuous efforts are making to bring order out of chaos in the matter of tribes, but nothing will be accomplished if confusion is constantly introduced by observers.

— Prof. T. G. Bonney read a paper before the Geological society of London on Nov. 7, on the geology of the South Devon coast from Tor Cross to Hope Cove.

— The relation of the state to the medical profession was the prevailing topic in the recent inaugural addresses before the schools of the several hospitals of London. Until 1858 the English people had virtually no protection against unqualified practitioners. In that year the act was passed establishing the present system of medical licensing.

A royal commission was appointed in May, 1881, to inquire into the existing provision, and to recommend such additional action as might seem advisable. The proposals of the commission were embodied in a bill which passed the House of Lords during the last session, but was lost in the House of Commons through the 'obstructive tactics of interested parties.' It is believed that the bill which will be presented during the next session will meet with better success. As pointed out by Professor Huxley in his address at the London hospital, 'three grave defects remain to be remedied:' viz., the low standard of examination allowed by some of the licensing bodies; the granting of licenses which do not involve proof of the holder's acquaintance with all three of the great branches of medical practice (namely, medicine, surgery, and midwifery); and the present state of the law, which does not permit the medical council to enforce equality of minimum examination, and the threefold qualification, before admitting a medical practitioner to the register. All of these points are included in the proposed bill.

It is further urged by those interested in the improvement of the profession, that liberal education should be a more general characteristic of its members, and that the student should bring to his medical course a more thorough preparation in physics, chemistry, and biology. Both of these ends will be furthered by the provision recently made in the two great universities for the sciences specified.

Socially the medical profession does not compare favorably with the other professions in England. The fact is curiously illustrated by an extract from a recent book quoted by Mr. W. H. Bennet in his address at St. George's hospital. "This choice of a profession," says the author, "is not an easy matter, when, as a rule, the church, the army, the bar, and the diplomatic service are almost the only professions open to a young fellow." Evidently, as Mr. Bennet observes, "the thought of medicine had never for an instant entered the writer's mind."

— Mr. Henry Brooks has prepared a useful series of specimens of the wood of several of the important timber-trees of the eastern states, for the use of teachers and students of natural history.

Each species is represented by three thin transparent sections of wood framed together, and cut in the direction of the layers of annual growth, at right angles with the grain, so as to show a cross-section of the trunk. The specimens mounted between thin sheets of mica permit a satisfactory examination of the position and size of the different ducts, cells, medullary rays, etc., besides showing admirably the color and general character of different woods. Architects and builders, therefore, as well as teachers, will find Mr. Brooks's contribution to a knowledge of our trees of considerable practical value. Complete sets, representing seventeen species, or single sheets, can be obtained by addressing Mr. Henry Brooks, 35 Bedford Street, Boston.

RECENT BOOKS AND PAMPHLETS.

Aramburu, F. Examen microscópico del trigo y de la harina, con algunas indagaciones de procedimientos analíticos para determinar su composición química y la del pan. Madrid, 1883. 156 p., illustr. 4°.

Bacas, D., and **Escadón**, R. Teoria elemental de las determinantes, y sus aplicaciones al algebra y á la trigonometria. Madrid, 1883. 196 p. 4°.

Berthelot, M. P. E. Explosive materials. Translated by M. Benjamin. With a short historical sketch of gunpowder, translated from the German of Karl Braun by Lieut. J. P. Wisser, U.S.A., and a bibliography of works on explosives. New York, *Van Nostrand*, 1883. (Van Nostrand's sc. ser., no. 70.) 180 p. 24°.

Bottero, E., and **Magistrelli**, C. Il telefono; con prefazione del Pietro Blaserna. Torino, *Loescher*, 1883. 82 p. 8°.

Bourguignat, J. R. Aperçu sur les Unionidae de la péninsule Italique. Paris, 1883. 117 p. 8°.

Brelow, G., and **Hoyer**, E. Lexikon der mechanischen technologie. Leipzig, 1883. 824 p., illustr. 8°.

Carrara Zanotti, L. Influenza del clima sulla salute. Treviglio, *Stabilimento sociale*, 1883. 112 p. 16°.

Coote, W. The Western Pacific; being a description of the groups of islands to the north-east of the Australian continent. London, 1883. 200 p., map, illustr. 8°.

Dammer, O. Lexikon der chemischen technologie. Leipzig, 1883. 875 p., illustr. 8°.

Dragendorff, G. Plant-analysis, qualitative and quantitative. Translated by G. Greenish. London, *Baillière*, 1883. 8°.

Ermacora, G. B. Sopra un modo d'interpretare i fenomeni elettrostatici: saggio sulla teoria del potenziale. Padova, *Draghi*, 1883. 40+468 p. 8°.

Exposition d'électricité, Paris. Expériences faites par Allard, Le Blanc, Potier, et Tresca. Méthodes d'observation; machines et lampes à courant continu, à courants alternatifs; lampe à incandescence; accumulateur; transport électrique du travail; machines diverses. Paris, 1883. illustr. 12°.

Franck, L. Kleine vergleichende anatomie der hausthiere. Stuttgart, 1883. 400 p., illustr. 8°.

Girard, M. Histoire naturelle; deuxième année. t. 1. Notions générales; anatomie et physiologie; mammifères; oiseaux. Paris, *Delagrave*, 1883. 11+708 p., illustr. 16°.

Gressent. Einträglicher obstbau. Neue anleitung, auf kleinem raum mit mässigen kosten regelmässig viele und schöne früchte in guten sorten zu erzielen. Berlin, 1883. illustr. 8°.

Hartmann, R. Die menschenähnlichen affen und ihre organisation im vergleich zur menschlichen. Leipzig, 1883. 313 p., illustr. 8°.

Huet, L. Nouvelles recherches sur les crustacées isopodes. Paris, 1883. 136 p., illustr. 8°.

Issel, A. Le oscillazioni lente del suolo o bradisismi. Saggio di geologia storica. Genova, 1883. 422 p., map, illustr. 8°.

Kroman, K. Unsere naturerkenntniss. Beiträge zu einer theorie der mathematik und physik. Ins deutsche übersetzt von R. v. Fischer-Benzon. Kopenhagen, 1883. 478 p. 8°.

Lewandowski, R. Die electro-technik in der praktischen heilkunde. Wien, 1883. (Elektro-techn. bibl., xviii.) 400 p., illustr. 8°.

Leydig, F. Ueber die einheimischen schlangen. Zoologische und anatomische bemerkungen. Frankfurt, 1883. 4°.

McCay, L. W. Beitrag zur kenntniss der kobalt-, nickel-, und eisenkiese. Inaug. diss. Freiberg, *Craz & Gerlach*, 1883. 46 p. 8°.

Morwood, V. S. Wonderful animals: working, domestic, and wild. Their structure, habits, homes, and uses; descriptive, anecdotal, and amusing. London, 1883. 288 p., illustr. 8°.

Nadaillac, Marquis de. L'Amérique préhistorique. Paris, 1883. 596 p., illustr. 8°.

Pancic, J. Orthoptera in Serbia hucdum detecta. (Serb. conscr.) Belgrad, 1883. 172 p. 8°.

Paolis, N. de. Questioni archeologiche, storiche, giuridiche, araldiche, a rifermare la sua 'Dissertazione sullo stemma di Marcianise' (Caserta, 1878) e ribattere le opinioni opposte. 2 vols. Catania, *tip. Nobile*, 1882. 8°.

Phipson, E. The animal lore of Shakspeare's time, including quadrupeds, birds, reptiles, fish, and insects. London, *Paul*, 1883. 492 p. 8°.

Richter, M. M. Tabellen der kohlenstoff verbindungen nach deren empirischer zusammensetzung geordnet. Berlin, 1884. 8+517 p. 8°.

Robustelli, G. Dalle statistiche dell' emigrazione. Roma *tip. Forzani*, 1883. 106 p. 8°.

Schneidemühl, G. Lage der eingeweide bei der Haussäugethieren nebst anleitung zu exenteration für anatomische und patholog.-anatomische zwecke. Hannover, 1883. 173 p. 8°.

Wood, J. G. New illustrated natural history: with designs by Wolf, Zwecker, Weir, and others. London, 1883. 796 p. royal 8°.

SCIENCE.

FRIDAY, NOVEMBER 23, 1883.

THE NOVEMBER MEETING OF THE NATIONAL ACADEMY OF SCIENCES.

For the first time in nineteen years, and the second time in its history, the National academy held its mid-year meeting in New Haven, Nov. 13–16. Thirty-three of the ninety-three members were in attendance, and during its four days' session twenty papers were presented.

The meeting was conspicuous for the discussion which most of the papers called forth, and for the general participation of the members in these discussions. It was interesting, also, for the report of the committee on the solar eclipse of last May, which included the detailed reports of the expedition to Caroline Island by the principal participants, Professors Holden and Hastings. It will further be remembered by the members from other cities for the marked hospitalities they received at the hands of their confreres of New Haven, and for its many social pleasures, culminating in the brilliant public reception given them by the president, Professor Marsh, at his residence. The new buildings recently finished, or in process of erection, for the furtherance of scientific research and instruction in Yale college, were also examined with interest, together with the treasures of the Peabody museum, where the finely mounted collections of Professors Verrill and E. S. Dana, and the fossil vertebrates of Professor Marsh, called forth much admiration.

The generous discussion to which the papers gave rise was provoked at the very start by the paper of Dr. Graham Bell upon the formation of a deaf variety of the human race, which had a broad, practical interest, and which consumed the entire morning session of the first day. Mr. Bell claimed, that, from purely philanthropic motives, we were pursuing a method in the education of 'deaf-mutes' distinctly tending to such a result, supporting his assertions by statistics drawn from the published reports of the different institutions in this country devoted to the care of these unfortunates. They are separated in childhood from association with hearing-children, and taught what is practically a foreign language, — a practice which isolates them from the rest of the community throughout their lives, and encourages their intermarriage. Such marriages were increasing at an alarming ratio, and with calamitous results. As a remedy for this danger, Dr. Bell would have the children educated in the public schools, thus bringing them into contact with hearing-children in their play, and in instruction wherever they would not be placed at a disadvantage, as in drawing and blackboard exercises. He would also entirely discard the sign-language, and cultivate the use of the vocal organs, and the reading of the lips.

The report on the solar eclipse covered a variety of topics, and will fill some hundred and fifty printed pages. In presenting it, Prof. E. S. Holden merely touched upon the principal points, and gave the leading results, in much the same form as they have already been given in this journal. The objects of the expedition were successfully carried out; and Professor Holden regarded his special work — the search for a possible planet interior to Mercury — as proving the non-existence of the small planets reported by Professors Watson and Swift.

Dr. C. S. Hastings read in full the greater portion of his report upon the spectroscopic work, which concluded with a critical review of the generally received theories of the solar atmosphere, and suggested, instead, that the corona was a subjective phenomenon, largely due to the diffraction of light.

The presentation of these reports occupied the entire morning session of Wednesday, and their discussion the greater part of the afternoon session.

In criticising the current use of the word 'light' in physics, Professor Newcomb opened a long and interesting discussion. He urged that photometric measurements were comparatively valueless, because they estimate a part only of the radiant energy of the sun; whereas the quantity which should be determined was the number of ergs received per square centimetre. Professor Langley, however, asserted that it would be impossible to estimate the radiant energy received from the stars with our present appliances: not all the stars combined would produce deflection, even in so sensitive an apparatus as the bolometer.

Another feature of marked interest was Professor Rowland's exhibition of photographs of the solar spectrum, obtained by his new concave gratings, by which he had prepared a map of the spectrum much more detailed than heretofore secured, and free from the defects of scale found in previous photographs.

Professor Asaph Hall communicated the results of his researches upon the mass of Saturn, based upon new measurements of the distances of the outer satellites. He determines the relative mass of the sun to that of Saturn to be as 1 to $\frac{1}{3482}$.

Professor Brewer took the occasion of the academy's meeting in the city of his residence to exhibit samples of his experiments of many years' duration upon the subsidence of particles in liquids. They showed the action of saline and organic matter, of acids and of freezing, upon the precipitation of sediments. Most of the samples had been undisturbed for five or six years, and showed varying degrees of opalescence, resulting from the suspension of matter in the fluid.

We have mentioned only the more important papers, or those which provoked a fuller discussion than usual. The following complete list will show how largely the physical side of science predominated at the meeting. In *astronomy*, besides the reports on the eclipse of May 6, papers were read by A. Hall, on the mass of Saturn; by S. P. Langley, on atmospheric absorption; and by O. T. Sherman (present by invitation), on personality in the measures of the diameter of Venus: in *mathematics*, by S. Newcomb, on the theory of errors of observation, and probable results: in *physics*, by S. Newcomb, on the use of the word 'light;' by W. H. Brewer, on the subsidence of particles in liquids; and by H. A. Rowland, on a new photograph of the solar spectrum: in *meteorology*, by E. Loomis, on the reduction of barometric observations to sea-level: in *geology*, by T. S. Hunt, on the Animikie rocks of Lake Superior; by J. D. Dana, on the stratified drift of the New-Haven region; by B. Silliman, on the mineralogy and lithology of the Bodie mining-district; and by J. S. Newberry, on the ancient glaciation of North America: in *chemistry*, by W. Gibbs, on phospho-vanadates, arsenio-vanadates, and antimonio-vanadates, and on the existence of new acids of phosphorus: in *physiological chemistry*, by R. H. Chittenden (present by invitation), on new primary cleavage forms of albuminous matter: in *paleontology*, by J. Hall, on the Pectenidae and Aviculidae of the Devonian system; and by O. C. Marsh, on the affinities of the dinosaurian reptiles: in *anthropology*, by A. G. Bell, on the formation of a deaf variety of the human race; and by J. W. Powell, on marriage institutions in tribal society.

The report of the committee on glucose, appointed by the president in conformity with a request from the government, was accepted by the academy, and will be transmitted to Congress with the president's report. This will also embody the proceedings of recent meetings of the academy, the report of the committee on alcohol, and that on the eclipse of the sun, together with the thanks of the academy to the secretary of the navy and the officers of the Hartford for their co-operation in the expedition to Caroline Island. It will also include an expression of the approval of the academy of the efforts now making to secure a system of uniform time.

The next stated session of the academy will be held in Washington in April next, and it is probable that the following mid-year session will be held in Cambridge.

THE WEATHER IN SEPTEMBER.

THE weather-review of the U. S. signal-service shows that in September there were two peculiar features, — the low mean temperature, and the deficiency in rainfall. The former was characteristic of all districts east of the Rocky Mountains, though the temperature was above the normal on the Pacific coast. The greatest deficiency in rainfall was in the east Gulf states, but the drought has been severe in various sections. Forest-fires burned over large tracts of land, causing the destruction of much property, especially in New England.

The accompanying chart exhibits the mean pressure, temperature, and wind-directions for the month, and needs no special comment. Nine barometric depressions were observed within the limits of the country, the average course being farther north than is usual. Of these, one was especially severe on the Lakes and in Canada, and one was a well-developed tropical hurricane. The latter was first observed near Martinique, on the 4th: it was very violent in the Caribbean Sea, and caused great destruction in the Bahamas, the loss of life being over fifty. It reached the North Carolina coast on the 11th, and was a destructive gale between Cape Hatteras and Wilmington, but lost its energy on reaching the land, and was wholly dissipated. While the damage from the hurricane was great, good service to commerce was rendered by the frequent warnings issued by the signal-service. The depression which existed on the 21st is worthy of note on account of its unusual track. It moved from Milwaukee, north-west to St. Paul, thence southward over Iowa and Missouri, and was the means of considerably modifying the effect of a cold wave which threatened extensive damage by frost. Five storm-centres are traced on the Atlantic, one of which is a continuation of the second of the August hurricanes described in SCIENCE, No. 37, and which passed over Great Britain. Four vessels only report passing icebergs.

With the approach of fall, frequent frosts are reported, and a frost-chart is a special feature of the review: it gives the limits of the regions in which frosts were experienced in connection with the three leading cold waves of the month. In contrast with this, maximum temperatures of 100° or higher were noted in Arizona, California, Idaho, Kansas, Louisiana, Nevada, Texas, and Utah; the highest being 122°.

The extent of the deficiency in the rainfall is indicated by the following precipitation table: —

Average precipitation for September, 1883.

Districts.	Average for September. Signal-service observations. For several years.	For 1883.	Comparison of September, 1883, with the average for several years.
	Inches.	Inches.	Inches.
New England	3.74	2.50	1.24 deficiency.
Middle Atlantic states .	4.14	4.47	0.33 excess.
South Atlantic states . .	5.94	6.63	0.69 excess.
Florida peninsula . . .	6.76	5.07	1.69 deficiency.
Eastern gulf	4.98	1.05	3.93 deficiency.
Western gulf	4.33	3.17	1.16 deficiency.
Rio Grande valley . . .	4.54	6.31	1.77 excess.
Tennessee	3.48	2.29	1.19 deficiency.
Ohio valley	2.49	1.53	0.96 deficiency.
Lower lakes	3.03	2.82	0.21 deficiency.
Upper lakes	3.98	2.78	1.20 deficiency.
Extreme north-west . .	2.24	1.01	1.23 deficiency.
Upper Mississippi valley,	3.45	1.67	1.78 deficiency.
Missouri valley	2.60	2.60	Normal.
Northern slope	1.26	0.89	0.37 deficiency.
Middle slope	1.59	3.02	1.43 excess.
Northern plateau . . .	0.78	0.06	0.72 deficiency.
Southern plateau . . .	1.22	0.57	0.65 deficiency.
North Pacific coast . . .	2.13	1.18	0.95 deficiency.
Middle Pacific coast . .	0.21	0.48	0.27 excess.
South Pacific coast . . .	0.03	0.04	0.01 excess.

The drought in the southern states is a continuation of that of former months, as is shown by the following table of deficiencies in the districts named: —

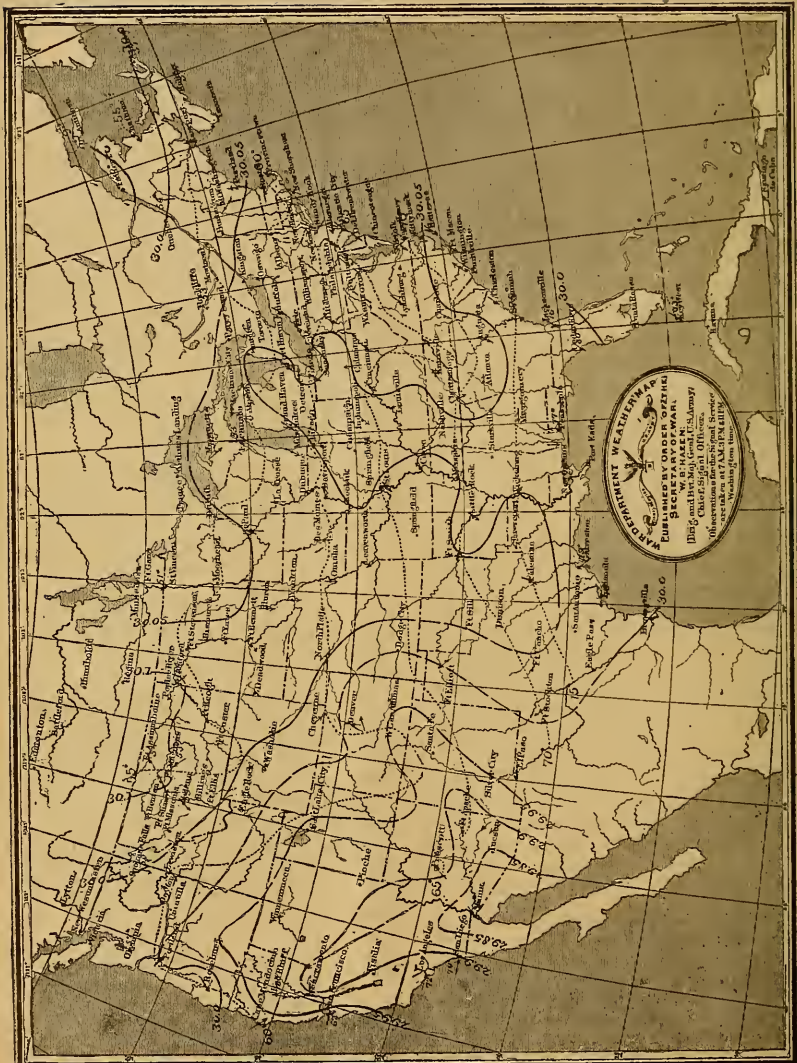
Districts.	July.	August.	September.	Total.
	Inches.	Inches.	Inches.	Inches.
Tennessee . . .	−0.99	−0.41	−1.19	−2.59
South Atlantic . .	−0.73	−0.72	+0.69	−0.76
Eastern gulf . . .	−2.54	−1.94	−3.93	−8.41
Western gulf . .	−1.72	−2.65	−1.16	−5.53

Several instances of great wind-velocity were recorded, the maximum being a hundred and eight miles per hour at Mount Washington on the 9th. At Cape Mendocino, on the Pacific coast, a maximum velocity of ninety-six miles was noted. The singular fact, not unusual, however, in the winter season, is deserving of mention, that the total movement of the air at Delaware Breakwater and Kittyhawk, on the Atlantic coast, is greater than that at the summit of Pike's Peak, the loftiest station in the world.

THE ELECTRIC LIGHT ON THE U. S. FISH-COMMISSION STEAMER ALBATROSS.[1] — II.

As superintendent of the building of the ship, my expectation was, that numerous and intricate problems would present themselves in running the wires about the iron hull, through

[1] Continued from No. 41.



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, SEPTEMBER, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF THE CHIEF SIGNAL-OFFICER.

iron bulkheads and beams, close to the boilers or hot steam-pipes, and through damp places.

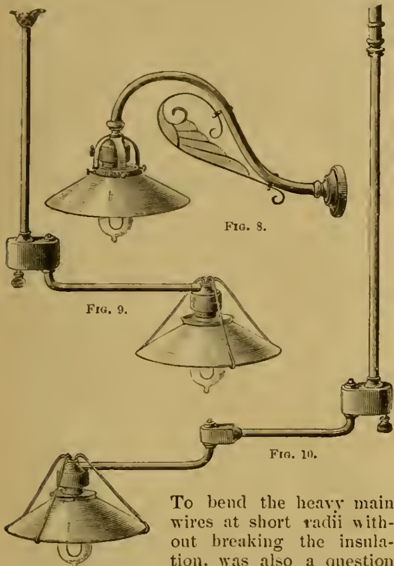


Fig. 8.

Fig. 9.

Fig. 10.

To bend the heavy main wires at short radii without breaking the insulation, was also a question that presented itself. But all these had been apprehended. Where the wires passed damp places, they were incased in rubber tubes, besides their insulation of cotton-cloth and white lead; in all hot places they were incased in lead pipe; where they passed through iron bulk-heads or beams, ferrules of hard rubber or gutta-percha were used; and the mains, instead of being single wires of large size, were composed of a number of smaller wires, which, of course, made them more flexible. Where the wires passed an iron surface, such as a lodger-plate or stringer, they were fitted to a groove in a wooden batten; and, where they passed a wooden surface, they were embedded into a groove cut in the wood; and, when carefully painted over, it is difficult to detect their presence. The main wires, as far as possible, were led behind the wooden lining of the ship. Where the wires were spliced or 'tapped,' their insulation was removed, and the naked metallic surfaces brightened with sand-paper, to insure metallic contact. They were then twisted together tightly, and soldered. The naked place was then covered with insulation-tape, which is common cotton tape saturated with a bituminous insulation compound manufactured by the Edison company, the components of which are kept a profound secret, and which an irreverent young man has named 'gulloot.'

The lamp-fixtures are designed to suspend the shade above, and to cast the unobstructed rays of the light downward. Handsome brass fixtures of three kinds, with porcelain shades, are used on board. Fig. 8 is called a bracket, and figs. 9 and 10 are single and double swing-brackets respectively.

The wires are run through the tubes of these brackets; but in the joints of the swing-brackets the current is transmitted through insulated hinges, to which the wires are fixed by binding-screws, as shown at *a* in fig. 11, by which arrangement the wires are not twisted in swinging the bracket.

The wires are brought to the binding-posts in the lamp-socket, fig. 12, between their binding-posts and brass conductors. One of these brass conductors is soldered to the thin spun brass socket into

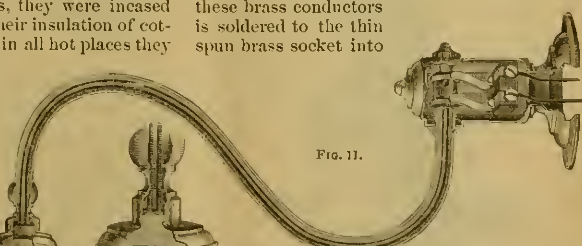


Fig. 11.

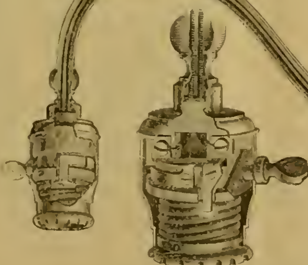
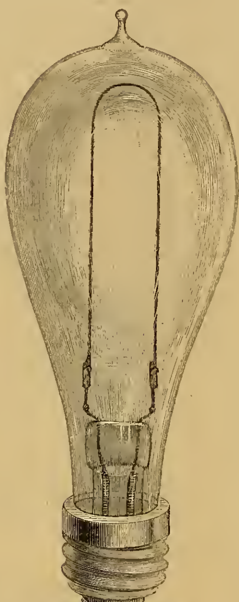


Fig. 12.

which the lamp is screwed, while the other is connected, through the key, to a brass disk, placed centrally in the bottom of the socket, against which one pole of the lamp presses when screwed in place. The key is mounted on a screw-thread of such pitch that one-fourth of a convolution will give it sufficient axial motion to open and close the circuit. The small number of parts used in these fixtures, their correct proportions, the adaptation of their forms to machine-tool manufacture, and their beauty of design, excite the admiration of the mechanic and the artist.

Fig. 13.



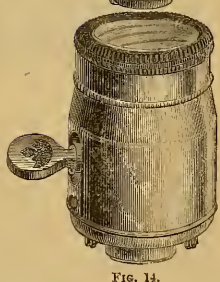


Fig. 14.

The lamps are of thin glass, pear-shaped, containing a thread of bamboo carbon about the thickness of a horse-hair. The small end of the lamp contains glass of sufficient thickness (fig. 13) to make a tight joint on the platinum-wire conductors which carry the current to the carbon. The atmosphere is exhausted from the lamp by Edison's modification of the Sprengel pump, through a tube at the upper end, and the tube is then fused and broken off. Platinum wire is used because its index of expansion is the same as glass, thus preventing any leakage or breakage from unequal expansion from the heat. The bamboo carbon and platinum wire are soldered together by electrically deposited copper. One wire, passing through the glass, is soldered to a small brass disk, which is centred on the bottom of the lamp, while the other wire is soldered to the spun brass screw-thread which surrounds the cylindrical part of the bottom of the lamp; and, when the lamp is screwed into the socket (figs. 14 and 12), the circuit may be completed or broken by the switch or key already described. When the circuit is closed, the carbon thread becomes heated, from its high resistance, to incandescence, and continues to glow, in vacuum, without burning, so long as the current continues to flow. The wires having a larger sectional area and higher conductivity carry the current without perceptibly warming. By varying the length or sectional area of the carbon thread, keeping the electromotive force constant, Edison has varied the candle-power of his lamps.

For example: let the electrical resistance be represented by R, the sectional area of the wire or carbon by S, the length by L, and the constant, dependent on the material of which the conductor is made, by a; then $S\ R = a\ L$, from which simple equation the relative sizes of carbons and wires may be determined, and proportioned to the tension in the circuit. Mr. Edison employs a number of different-sized dynamos, which he designates by letters; but he winds them for but two tensions, i.e., the *A* and *B* circuits. The *A* lamp belongs to the *A* circuit, as its carbon thread is of such resistance that the *B* circuit would heat it to only a cherry red. A *B* lamp, however, in the *A* circuit, would acquire an intense brightness, but its duration would be very limited. Two *B* lamps in series, in the *A* circuit, would, by their augmented resistance, glow at about their normal incandescence.

The average life of a lamp is said to be about 1,000 hours, when kept up to its normal incandescence; but they will last much longer if their brightness is a little suppressed. This may be effected either by throwing in resistance, or by slowing the engine. On board ship, however, about as many lamps are broken by accident as from natural deterioration.

The cost of the lamps is one dollar each; and, at the present rate of consumption from all causes, the annual expenditure will be 56 lamps. The dynamo is run about 2,190 hours per year (about six hours per day), with an average of about $47\frac{1}{2}$ lamps in circuit, so that the annual lamp-hours would be about 104,025 (2190 × 47.5). Thus it appears that our lamps will, at present consumption, last us in the neighborhood of 1,857 ($\frac{104025}{56}$) hours each.

Description of lamps.

Designation of lamps.	Candle-power.	Resistance in ohms.	Current in ampères.	Electromotive force in volts.
A	32	86	1.180	102
A	16	137	0.745	102
A	10	250	0.400	102
B	8	69	0.745	51
B	16	42	1.200	51

In event of a short circuit through a good conductor, between the wires there would be instantly generated heat of such intensity that the wires would melt, and perhaps the armature also. This heat would in all probability set fire to the wood-work along the line of the wire. To prevent this, Edison has devised his cut-out block, or safety-catch, — a neat device for placing a short piece of alloy in the circuit, which, at 400° F., will melt, and open the circuit. When this happens, all the lamps on the branch circuit fed through that cut-out will be immediately extinguished; and, though one is left in darkness at that point, he is rewarded by a consciousness of greater mischief having been prevented. Fig. 15 represents a double pole cut-out block, a front and back view of the cut-out plug, and a binding-screw. Fig. 16 shows a back view of the same cut-out block, and a section through a cut-out plug. The fusible alloy is contained in the plug, and is utilized as a solder to unite the two poles of the plug. The plug is made similar to the bottom of a lamp, and the block-socket is similar to a lamp-socket. The wires are held by the binding-screws, and the current passes through the metal of the block and plug. These cut-outs are placed on each of the main circuits, near the dynamo, and on each branch circuit, and always in convenient positions. The alloy in the plug is the only part destroyed by a short circuit, and it is only a minute's work to substitute a new plug.

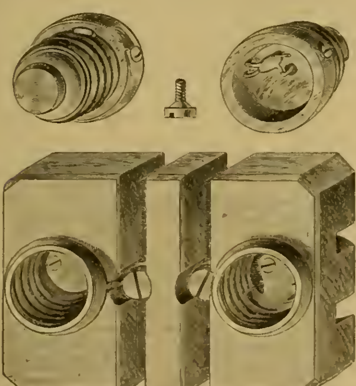


Fig. 15.

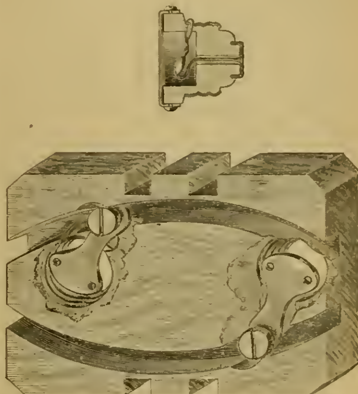


Fig. 16.

(*To be continued.*)

REPORT OF THE GERMAN CHOLERA COMMISSION.[1]

When the commission arrived in Egypt, the cholera epidemic had already begun to decline, so that we could not expect to obtain all the material necessary for carrying out our examinations. Besides, since the termination of an epidemic is the least suitable time for etiological researches, our original plan was to make such preliminary studies as we could in Egypt, and then check our results, as soon as the epidemic had reached Syria, by further investiga-

[1] Report to Minister von Böttleher, secretary of state for the interior. By Dr. Koch. From the *Kölnische zeitung* of Oct. 17.

tions in suitable localities in that country. We were able to carry out the first part of our plan in accordance with our wishes; for the commission found abundant opportunity, during its stay in Alexandria, to collect the material necessary for its preliminary researches. This was mainly due to the active cooperation of the physicians of the Greek hospital, who furnished us working-rooms, permitted us to study the cholera cases in the hospital, and placed the bodies of those who died of the disease at our disposal.

At first the commission had two rooms of the hospital, adjoining each other on the ground-floor, and well lighted. In one room the microscope work was carried on, and in the other the culture experiments. The animals experimented on were at first brought into both rooms. But when their number had been increased, it was thought too dangerous to manipulate the material for infection in the same rooms in which we had to spend nearly the entire day, and they were accordingly removed to another room in the old hospital; and there the experiments on infection were made.

The material for experiment was obtained from twelve cholera patients, and ten bodies of individuals who had died of the disease. The cases of nine of the patients were studied in the Greek hospital, two in the German, and one in the Arabian. The symptoms corresponded in all cases with those of true Asiatic cholera. Specimens of the blood, of the vomited matter, and of the dejections of these patients, were taken, and submitted to examination. It was soon apparent that the blood was free from micro-organisms, that the vomited matters were comparatively poor in them, but that the dejections contained a considerable quantity; and the latter material was therefore mainly used in the infection experiments with animals.

Although the number of bodies used for dissection was small, the material they afforded was of the greatest service in localizing the disease. They represented the most varied nationalities (three Nubians, two German-Austrians, four Greeks, and one Turk), were of different ages (two were children, two over sixty years of age, and the others between twenty and thirty-five years), and the duration of the disease varied in the different cases. The most important fact, however, is that dissection could be begun immediately or in a few hours after death. The changes produced in the organs, and especially in the intestines, by putrefactive decomposition shortly after death, which render microscopical examination difficult, and its results generally entirely deceptive, were thus effectively guarded against. I wish to lay particular stress on this circumstance, because it is hardly probable that such excellent material for microscopic examination as we obtained could be found in other places.

The appearances of the bodies, as well as the symptoms of the sick, left no room for doubt that we had to deal with true cholera, and not, as at first supposed, with diseases resembling cholera, — the so-called 'choleriform' and 'choleroid' diseases.

We were unable to detect any organized infectious matter in the blood, or in the organs which are usually the seat of micro-parasites in other infectious diseases; viz., the lungs, spleen, kidneys, and liver. Occasionally bacteria were found in the lungs; but it was clear from their forms and position that they had nothing to do with the processes of the disease, but had entered the lungs from the vomited matter by aspiration. In the contents of the intestines, just as in the choleraic dejections, there was an extraordinarily large number of micro-organisms of different kinds, no one of which was present in excessive proportion. There were also no special indications which could enable us to draw any conclusions as to their connection with the disease. On the other hand, the examination of the intestine itself gave a very important result. In all cases but one, a specific form of bacteria was found in the walls of the intestine. The exception was in the case of a patient who had died of a *sequela* several weeks after the cholera had subsided. These bacteria were rod-shaped, and therefore belong to the bacilli. In size and shape they most nearly resemble the bacilli of glanders. In cases where the intestine showed the slightest evidence of change, the bacilli had penetrated into the tubular glands of the mucous coat, and had set up a considerable irritation there, as was shown by the distension of the glands, and the accumulation of many-nucleated round cells in their interior. In many cases, too, the bacilli had worked their way beneath the epithelium, and had penetrated between it and the gland membrane. Moreover, they had planted themselves in large quantities over the surface of the villous coat of the intestine, and had penetrated its tissue. In severe cases of the disease, where there was a bloody infiltration of the mucous coat of the intestine, the bacilli were present in great numbers, and had not confined themselves to the invasion of the tubular glands, but had entered the surrounding tissue in the deeper layers of the mucous coat, and sometimes had penetrated to the muscular coat. The villous coat was also thickly covered with them in such cases. The principal seat of all these changes was found to be the lower part of the small intestine. In investigations like the present, the examination ought to be made on perfectly fresh bodies, because putrefactive decomposition can induce similar growths of bacteria in the intestine. From this consideration I was unable last year to attach any value to the discovery of the same bacilli in the same position in the intestines of cholera patients which I had obtained directly from India, because I was afraid of complications with *post-mortem* changes. This former discovery, which was made in the intestines from four bodies of persons who had died of cholera in India, is now confirmed, because there can be no error in the present case due to decomposition in the Egyptian bodies. The inference, too, that the correspondence in the conditions of the intestine in the Indian and Egyptian cholera may be taken as a further indication of the identity of the diseases, is not without weight.

The number of bodies of cholera patients used by the commission for examination, it is true, was small.

Bacilli were found in all the fresh cholera cases, but were wanting in the case where death had occurred after the symptoms of cholera had disappeared, and in others where death had not occurred from cholera, in which examinations were made for the sake of comparison; so that there can be no doubt that these organisms have some connection with that disease. But it is too much to conclude yet that bacilli are the cause of cholera because they are found in the mucous coat of the intestine of cholera patients. The inference might be reversed; and we might say that the disease produces such changes in the mucous coat, that some of the many bacteria present there as parasites are able to penetrate the tissue. A decision of the question, which of the two views is correct, — whether the infection or the bacteria invasion comes first, — can only be settled experimentally by collecting the bacteria from the diseased tissue, breeding them by 'pure culture,' and then reproducing the disease by infection experiments on animals. For this purpose it is necessary, first of all, to have such animals at our disposal as are susceptible to the infectious matter; but in spite of every effort to infect animals with cholera, it has not yet been demonstrated that they can be made to take that disease. Experiments have been tried with rabbits, guinea-pigs, dogs, cats, monkeys, pigs, rats, etc., but always without success. The only statements to the contrary, worthy of notice in this connection, are the accounts of Thiersch's experiment with mice which he fed with the contents of the intestine of a cholera patient, and which were then attacked with diarrhoea, and died. This experiment has been confirmed by reliable experimenters, like Burdon-Sanderson, and has been criticised, and the conclusions drawn from it disputed by others. We considered it necessary to repeat this experiment because it was of the utmost importance for our purpose to discover some species of animal capable of infection with cholera.

Fearing that the requisite number of mice could not be obtained at once in Alexandria, we carried fifty of those animals with us from Berlin, and began the infection experiments with them. We also experimented with monkeys, — because they are the only animals susceptible to certain human diseases, such as small-pox and relapsing fever, — and, besides these, with a few dogs and chickens. But, in spite of all our care, the experiments were failures. The most varied samples of vomited matter, choleraic dejections, and contents of the intestines from bodies of persons dead of cholera, — sometimes fresh, sometimes after standing some time in a cool or warm place, and sometimes in a dried condition, — were fed to these animals; but no symptoms of cholera appeared, and they remained perfectly healthy.

Besides this, 'pure culture' experiments were made with bacilli taken from the contents of the intestine and its walls. The material obtained in this way was fed to the animals, and inoculation was also tried. This latter method, with the products of the 'pure culture,' sometimes produced septic diseases; but no symptoms of cholera appeared.

That the material of the disease is very often contained in the dejections of cholera patients in an active form, is shown in several ways, and particularly by the frequency of the disease among washerwomen who wash clothes soiled with such dejections. A case in point occurred during the present epidemic in the Greek hospital, where a washerwoman who washed for the cholera hospital exclusively was taken with the disease. It is therefore certain, that, of the numerous samples used in our experiments, some at least must have contained the infectious matter. But since our experiments were failures, it must be assumed, either that the animals we used are not susceptible to cholera, or that we had not discovered the right method of producing infection. At any rate, the experiments ought to be repeated and modified; but, with the material now at our command, there is little prospect that they would prove successful.

Our want of success may possibly be explained in still another way, which is this. In a place visited by the cholera it is usual for the disease to cease before all the inhabitants have been attacked; and, although the infectious material is scattered about in great quantity, fewer and fewer persons are affected by it, and the epidemic at last dies out in the midst of individuals capable of taking it. This circumstance can only be explained on the theory that the infectious matter loses its activity, or at least becomes uncertain in its action, towards the end of the epidemic. If, therefore, human beings become less susceptible to the infection of cholera towards the end of the epidemic than at its outbreak, it can hardly be assumed that the animals used for experiment, of whose susceptibility to infection we know nothing, should differ from them in this respect. And for our experiments we could only obtain material which had been collected towards the end of the epidemic, and which must be presumed to have been more or less inactive. It is of course possible, that under suitable conditions, such as the outbreak of a cholera epidemic, the infection of animals with the disease might be successfully accomplished; and such would be the proper time to determine by experiment whether the bacilli I observed in the mucous coat of the intestine constitute the true cause of cholera.

However far the commission may still be from a complete solution of the problems proposed to it, and although its labors have contributed little which may prove of practical value in combating the cholera, yet, considering the unsatisfactory conditions under which the experiments were made, and the short time the commission was able to devote to them, the results thus far obtained should be regarded as encouraging. The experiments fully answer the original purpose of localizing the disease, and, by ascertaining the constant presence of characteristic micro-organisms, have supplied the first condition for the investigation of infectious diseases, and afforded a determinate object for further research.

From the foregoing statements, it is clear that the commission can accomplish no more in Alexandria than has already been done. It might be thought that it could pursue its investigations in some other place in Egypt where the cholera prevails, but there are insuperable objections to such a plan. The cholera has disappeared from all the large cities of the country, and only holds its own in the villages of upper Egypt; and an attempt to carry on our experiments in that part of the country would meet with the strong disapproval of the Egyptian government on account of the disagreeable complications in which the condition of affairs there might involve us. Moreover, I have been assured by responsible persons well acquainted with the Egyptians, that it would be impossible to obtain material for dissection in Egyptian villages; and for these reasons I must renounce all hope of following the course of the cholera up the Nile. The disease also, contrary to all expectation, appears to have gained no foothold in Syria. Since the investigations now in progress will occupy only about two weeks, the work will soon have to be temporarily suspended. The commission, however, entertains a strong desire to prosecute its researches further, and satisfy the object for which it was created. It would be a great disappointment if the results it has already reached should prove fruitless from want of further experiments. The only opportunity which is afforded us at present for continuing our researches is in India, where the cholera is still prevalent in several large cities, particularly in Bombay, and is not expected to subside immediately. It is also probable that we could gain access to some hospital there, and repeat the work which proved so valuable in Alexandria. In case, in your excellency's opinion, it should be deemed advisable to continue the researches of the commission, and extend the field of its labors to India, I am ready to continue in charge of its management.

I must also say a few words about the additional labors which the commission has found time to prosecute in connection with its researches on cholera. Egypt is full of parasitic and contagious diseases, and it was not difficult to obtain suitable material for the examinations we wished to make in order to control the results obtained in studying the cholera, and also to settle some general questions bearing on infectious diseases. For example: I dissected the bodies of two persons who had died of dysentery. In one case, where the patient had died of an acute attack, there were parasites in the mucous coat of the intestine which did not belong to the bacteria group, and were unknown. I also dissected the body of an Arab who had died in the Arabian hospital of malignant disease. The disease in this case was probably taken from sheep, which are imported into Egypt from Syria in great numbers, and die of anthrax *en masse*. I was also afforded an opportunity to observe six cases of bilious typhus in the Greek hospital. This disease closely resembles yellow-fever, with which it is often confounded, and presents much interest to the student. Three of these patients died, and were dissected.

Besides this work, repeated examinations were made of the micro-organisms in the air, and the drinking-water of Alexandria. If time allows, I intend to study the Egyptian ophthalmia.

The labors of the commission, which from their nature were very trying and fatiguing, and for the most part of a disagreeable character, were rendered doubly irksome by the high temperature prevailing in the city. It has been impossible to interrupt the work a single day until now. Nevertheless, the members of the commission are in good health, and have only suffered from some slight complaints, due to a change of climate, which soon disappeared. However, as soon as the condition of the work will allow, I consider it advisable for the commission to rest a few days. I intend, therefore, to go with it to Cairo for a short time, partly for the sake of recreation, and partly in order to visit the principal seat of the cholera in Egypt, and make further observations there.

THE PHYSIOLOGICAL STATION OF PARIS.[1] — I.

We have seen in the last few years all kinds of establishments erected to provide for the new needs of science. Laboratories, although great discoveries have been made in them, have become in certain respects insufficient. In the study of organized bodies, as in that of the physical forces of the earth, one is soon brought to a standstill if he cannot study nature in her own domain.

Special establishments for certain sciences, astronomy for instance, are a necessity; and lately naturalists have perceived the insufficiency of the means placed at their disposal. Maritime stations, gardens for acclimation, experiment stations, agricultural stations, stations for vegetable chemistry or experimental medicine, — all these have responded to the development of certain branches of science.

Physiology, almost the only exception, has been, up to the present time, dependent upon laboratories. These are, in France at least, wretched places, poor and unhealthy, where the investigators are obliged to live in the hope of discovering the properties of the tissues, and the functions of the living organs. There is discovered the action of medicines upon the living organism, of poisons, and the various chemical and physical agents; there, by means of vivisection, or by the use of the proper and delicate instruments, the inner mechanism of the vital functions is analyzed.

This condition of destitution could not continue. It is evident, that with the means at its disposal, within narrow limits, and compelled to operate upon a few lower animals, physiology could not but remain behind the other sciences. In any case, it could not hope to attain its full development: it must abandon, without practical application, the knowledge that it had obtained at the cost of so great efforts.

In the last half-century physiologists have written a large number of works on the nervous and muscular systems. We have learned to distinguish the nerves

[1] By E. J. Marey of the French Institute. Translated from *La Nature*.

of sensibility and those of movement; to determine the courses of the two kinds of nerves in the various parts of the body. We know how excitations, according to their intensity or nature, act on these organs. We have measured the rapidity with which that still mysterious agent, which bears to the muscles the order for motion, travels in the nerves and in the spinal marrow. We have separated the action of the muscles in their elements, — undulatory vibrations which traverse the length of the muscular fibre. Finally, we have studied the nature of contractions, and know how fatigue, heat, cold, and poisons affect these movements.

On the other hand, while considering the mechanical conditions of animal locomotion, we have determined, from a kinematic stand-point, the characters of the various movements of man and animals. We have classified according to their kind the different bony levers of the skeleton, have determined the centres and radii of curvature of the joints, and have estimated the momentum of the opposing forces which represent the power and the resistance in the animal machinery.

It appears now that every thing is ready, and that physiologists have only to apply these studies to the various problems of practical life. They will teach us, doubtless, how best to utilize the muscular work of man and of the domestic animals; they will lay down rules which shall control the physical exercises of the young, the work of the artisan, the drill of the soldier.

Unfortunately it is not so. Limited as they are, physiologists are scarcely able to study the vital functions in man and the more important animals; besides, the usual method, vivisection, which has disclosed so much in regard to the properties of the tissues and the functions of separate organs, cannot discover the regular action of normal life.

The writer of this article has spent long years in his search for methods and an apparatus capable of faithfully interpreting the external signs of the functions of life. The pulsations of the heart or the arteries, the respiratory movements, the contractions of the muscles, record themselves with this apparatus, and obtain, for analysis, curves in which the least details of the movements are represented. The object of other instruments is to trace the course traversed by a man or by an animal, or to express the efforts developed as functions of the time. Recently, instantaneous photography has completed the knowledge of physiological movements, so that to-day we can easily solve most of the problems of the animal mechanism.

But if the methods were perfected, if new apparatus were invented, all the difficulties would not be removed; for it is not in the ordinary physiological laboratories that one can study the motions of a bird on the wing, of a galloping horse, or of a man walking, running, or performing some other muscular exercise. It was to promote these researches on the physiology of man and animals, that the physiological station, of which we will give a description, was erected.

Only the municipal council of Paris could grant land adequate for this kind of experiments. There was a very convenient place on the Avenue des Princes, near the Porte d'Auteuil. With the generosity always shown when science is concerned, the council granted these lands, and even voted a subsidy to cover a part of the expense of experiments. On the other side, Mr. Jules Ferry, the minister of public instruction, pleaded warmly before the chambers in favor of the contemplated establishment. A law, passed in August, 1882, granted the sums for the construction of the necessary buildings. The work was pushed actively forward during the last autumn and winter, and in March experiments were begun at the physiological station.

The practical applications of physiology are infinite; but in this vast number there are certain questions whose solution is near at hand, certain others for which nothing is prepared. The management of the physiological station, although the subsequent needs are foreseen, is, for the present, arranged for the study of the animal mechanism; and the experiments under progress relate to human locomotion.

The problems which present themselves first of all are the following: 1°. To determine the series of motions which are produced in human locomotion of various kinds, — walking, running, leaping; 2°. To search for the external conditions which influence these motions; those, for instance, which increase the rapidity of pace or the length of step, and which thus exercise a favorable or an unfavorable influence upon the locomotion of man; 3°. To measure the energy expended each instant, in the various acts of locomotion, in order to discover the most favorable conditions for the utilization of this energy. Instantaneous photography, and various other appliances of the graphic method, help to solve these problems, which are impossible to direct observation.

Before entering into the details of the experiments, we will describe the general arrangement of the physiological station. Fig 1. shows the land and the building as a whole. A circular and perfectly level course is laid out in a piece of ground used by the city of Paris as a nursery. This course has two concentric tracks: the inner one, four metres wide, is for horses; the outer one, for men. Around these tracks runs a telegraph-line, whose poles are fifty metres apart. Every time a walker passes a post, he causes a telegraphic signal; and this is recorded in one of the rooms of the principal building. We shall refer later to this kind of automatic record, by means of which, for every minute, the rapidity of the walk, the accelerations and diminutions, and even the number of steps, may be known. In the centre of the course is an elevated platform, on which a mechanical drum beats the time for the step. This drum is worked by a special telegraph-line, coming from a room in the large building where the rhythm is maintained by a mechanical interrupter.

From the centre of the course runs an iron track, on which rolls a little carriage forming a photographic studio. From within this apartment a set of instantaneous pictures of the men and horses whose gaits are to be studied, may be taken. These photographs are taken as the walker passes before a black screen. Finally, the dynamographic studies, to measure the energy exerted in the various muscular motions, are possible by means of apparatus which will be described later.

Our readers are already familiar with the history, in detail, of the applications of instantaneous photography to the analysis of the locomotion of man and animals. Many have seen the beautiful pictures obtained by Mr. Muybridge, who has succeeded in photographing a horse running at full speed. For the requirements of the physiological analysis of movements, we have substituted for the complex apparatus of Mr. Muybridge a simple contrivance, giving on the same plate the successive positions of a man or an animal at various instants of his passage before the black screen. We shall refer to these experiments in order to describe certain improvements which make the figures more clear, the time-measurements more exact, and which, by multiplying almost indefinitely the number of images, give a complete analysis of all kinds of movements.

The apparatus employed at the physiological station for the instantaneous photography of movements comprises two distinct parts, — first, the photographic apparatus, with the room on wheels, which holds it; and, secondly, the black screen, on which appear in white the men and animals whose pictures are being taken, as well as the instruments for measuring the distance run, and the time consumed between two successive photographs.

Fig. 2 represents the photographic chamber where the experimenter is. This room is on wheels, and is arranged on an iron track, so that it may approach or move from the screen, according to the objectives which are employed, and the desired size of the photograph. Generally it is convenient to place the photographic apparatus about forty metres from the screen. At this distance, the angle at which the subject to be photographed is presented, changes little during his passage before the black screen. From the outside of this building may be seen the red glass through which the operator can follow the various motions which he is studying. A speaking-trumpet enables him to direct the different movements which ought to be made. The front wall of the building is raised in the figure, in order to show a revolving-disk, provided with a little window, across which the light passes intermittently into the objective. This disk is of large size (1.30 m. in diameter), and its window represents only a hundredth of its circumference: hence, if the disk revolve ten times a second, the duration of the lighting is only one-millionth of a second. The movemement is recorded on the disk by wheel-work, which is wound

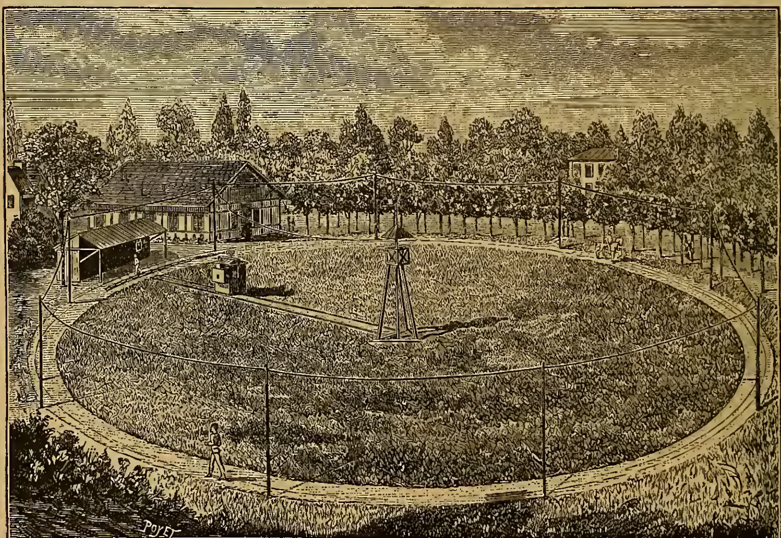


FIG. 1. — PHYSIOLOGICAL STATION AT PARIS.

by a crank, and set in motion by a weight of a hundred and fifty kilograms placed behind the building. A brake checks the disk. A clock-bell, regulated from within, notifies an assistant either to set in motion or to stop the disk.

Fig. 3 shows the interior arrangement of the chamber. The removal of one of the side-walls discloses the photographic apparatus, *A*, placed on a bracket, and directed toward the screen. This instrument receives the long and narrow sensitive plates, which just admit the image of the whole screen. The plates which give the best results for the shortest exposures are those of Van Monckhowen of Ghent, and that of Melazzo of Naples. At *B* is the revolving-disk, which produces the intermittent light; at *D*, a shutter, which is raised vertically at the beginning of the experiment, and falls at the end in order that the light may enter the apparatus only during the time absolutely necessary. *E* is a long slit which unmasks before the objective the field in which the movements to be studied are taking place. The darkness of the chamber permits one to handle at his ease the sensitive plates, and to change them for each experiment.

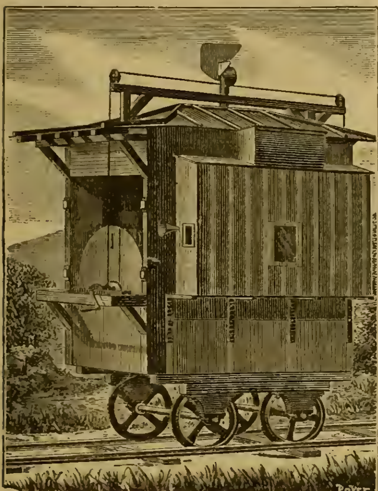


FIG. 2. — ROLLING PHOTOGRAPHIC CHAMBER.

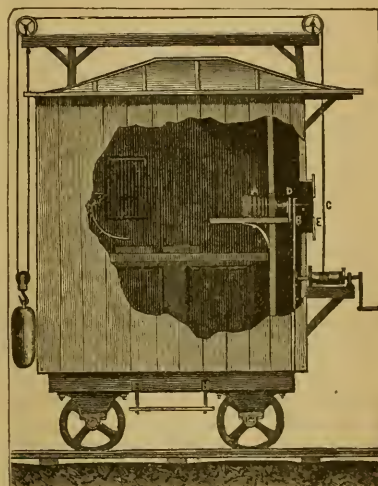


FIG. 3. — INTERIOR OF PHOTOGRAPHIC CHAMBER.

(To be continued.)

SEPTEMBER REPORTS OF STATE WEATHER-SERVICES.

THESE reports emphasize the general lack of rain, which, without exception, was characteristic of the weather prevailing in every state issuing reports. The low mean temperature is also made a subject of note.

Georgia. — In this state there has been no general rain since April 23, and the crop reports are in consequence unfavorable. Cotton averages sixty-two per cent, and corn seventy-six per cent, of the usual yield. The temperatures ranged between 45°, the minimum in the northern portion, and 95°, the maximum in the southern section. The average rainfall was 1.57 inches.

Indiana. — The temperature averaged 3.5° below the normal for September; and frosts occurred on the 6th, 10th, and 26th, damaging late corn and other vegetation. The prevailing wind was north-east. The rainfall ranged from 0.15 inch to 5.98 inches, averaging 1.99 inches for the state.

Kansas. — At Lawrence the rainfall was smaller and the temperature lower, with one exception, than any other September for sixteen years. Rain fell on seven days, and there was but one thunder-shower. The mean cloudiness was 40.33 per cent, the month being 0.31 per cent clearer than usual.

Missouri. — At St. Louis the rainfall was less than a hundredth of an inch, which has not happened before since Dr. Engelmann began his observations in 1839. The normal rainfall at St. Louis is three inches. Several other stations report no rainfall. Light frosts occurred, but without material damage to the corn-crop, except over limited areas on low ground.

Ohio. — The barometric conditions were normal; but the temperature was about four degrees below the average, and the rainfall showed a deficiency of nearly an inch. The bureau is gradually increasing the number of stations, and makes special efforts to have its observers supplied with standard instruments. In addition to its regular stations, it invites the co-operation of voluntary observers, and will furnish reliable instruments at reduced prices. The rainfall chart published by this service is deserving of being introduced into other similar reports.

Tennessee. — The continued drought has damaged the crops, especially in the eastern portion; but in the middle portion the crops are in fair condition. Frost visited some localities, the temperatures in the state ranging from 32° to 95°. The prevailing wind was north; the average rainfall, 2.06 inches; the average number of clear days, 14.

LETTERS TO THE EDITOR.

Teaching language to brutes.

Is it not quite conceivable that some of the lower animals might be taught to use human language rationally? No doubt the reasons for a first hasty answer in the affirmative would be that the animals seem so intelligent as sometimes even to reason, and that they have, in fact, often had human words put into their mouths, and that they seem sometimes to have a language among themselves. Yet, after all, cannot their intelligence, and even wisdom, and occasional apparent reasoning, be satisfactorily explained, without attributing to them true reasoning, as the result of hundreds or thousands of generations of experience and transmitted memory, by which certain objects or actions become associated with a feeling of pleasure or pain that induces pursuit or avoidance? How few, indeed, are the cases that cannot readily be so explained, where an animal appears at first sight to exercise a reasoning-power! and how extremely simple the effort seems then to be!

True reasoning can always be reduced to the syllogistic form, in effect a statement that what is true of a class is true of something in that class. In order, then, to reason, properly speaking, it is necessary to use a general term (a word or sign with the meaning of a common noun) to indicate the class; and, as we do not know of any evidence that brutes have such words or signs, we have no proof that they can reason. In like manner, the lack of evidence that they can reason goes far towards showing that they have no language that includes such general terms, though it may be true that they sometimes understand words in a singular (not general) sense, and have similar expressions for their own feelings.

The question, then, is whether brutes may not be taught the intelligent use of general words or common nouns, which would enable them to reason. As the step does not seem so very enormous from the undeniable intelligence of some brutes to the lowest form of generalization, it is perhaps worth while to consider how they might possibly be taught to take the step, in hope, that, having once taken it, they might be led farther with still greater ease. Since the idea of plurality appears to lie at the very bottom of the idea of class, number would perhaps be the first and simplest step in generalizing, — number, that is, the regarding things merely as individuals or units. It is a step beyond, to regard things as alike in more complex respects. If that is so, the first effort might be made to teach how to count, and, of course, at the beginning only to count up to two. If that can be accomplished, still further counting can unquestionably be taught, and no doubt by degrees a much greater amount of generalization and reasoning itself. Does it seem impossible that a brute may learn to associate invariably the word 'one' with a single object, and 'two' with a pair of objects, no matter of what kind? At first the two objects should always be two like ones; but by degrees a difference in them might be allowed. The teaching of common names might next be taken up; or it might be begun along with the counting, but without the confusing addition of any plural termination. Even if the mere counting up to two could not be taught successfully to any single individual brute, yet the end might nevertheless be attained, perhaps, in several generations.

The question then comes, With what animal would it be best to begin such experiments, — whether with monkeys, or elephants, or birds, or ants? Of course, articulation is not essential; for a language of signs might be devised suitable to the animal, — a language corresponding to the deaf-and-dumb one of signs, or to one using the Morse alphabet, or something like it. Elephants are very intelligent, but so very long lived that it would take ages to observe the effect of training through many successive generations. Perhaps the convenience of excellent articulation and rapid propagation, both combined with apparently good intelligence, might give the preference, on the whole, to a talking bird, such as the Indian mynah. L. B.

Nov. 9, 1883.

Climate in the cure of consumption.

In your issues of Sept. 28 and Oct. 5, Dr. S. A. Fisk of Denver, Col., compares the climates of the principal health-resorts of the United States with one he happens to represent, i.e., Colorado. At the commencement of his paper the writer states that "he has given the data for Augusta, Ga., as the best substitute for Aiken, S.C., at which place there is no signal-station; and, in doing so, he thinks that he is presenting data which will fairly represent the climatic condition of Aiken." To those familiar with the two places, this is, indeed, a most astounding revelation; and, with your kind permission, I hope to prove, that, although socially very dear to each other, they have climatically but little in common. Augusta is built upon a marshy flat on the Savannah River, which at times overflows its banks, and submerges a portion of the city; while Aiken is located in what is known as the sand-hill region, five hundred and sixty-five feet above sea-level, which is higher than any other town or village within a radius of seventy miles. The soil of the latter place is dry and porous; and to obtain water, wells have to be sunk to a depth of from a hundred to a hundred and twenty feet; and there is no water-course within two miles of the town, and even at that distance there are but brooks or small creeks. The result of this absence of soil-moisture, and of large bodies of water, would of itself tend to diminish the amount of humidity in the atmosphere; but this is still further diminished by the absence of any hill or mountain to interrupt the free circulation of the wind. Augusta, on the contrary, is situated, as before stated, on a plain lying between a range of hills and the river. All this would lead one to expect that the climate of Aiken would be extremely dry; and that this is really the case is proved by carefully conducted observations extending over many years, which show that the average relative humidity, fifty-eight per cent, is lower than that of any other station east of the Rocky Mountains, and eleven degrees less than the figure given by Dr. Fisk as the mean of four years' observation at Augusta. As further proof of the dryness of the atmosphere of Aiken, I would direct attention to the absence of mould on boots and shoes, and to the fact that guns, and even delicate surgical instruments, may be exposed to air for months at a time without rusting. There are many other differences between the climates of Aiken and Augusta; but the above is sufficient to show that Dr. Fisk has indulged in an inference, when, with a little trouble, he could have obtained facts, the meteorological data for Aiken being on file at the office of the chief signal-office, U. S. A., since the establishment of that bureau, and prior to that time at the Smithsonian institution, not to speak of various publications on the climate of Aiken, which have appeared in the different medical journals of the country.

W. H. GEDDINGS.

Aiken, S.C., Nov. 5, 1883.

On the possible connection of the Pons-Brooks comet with a meteor-stream.

I desire to call attention to some slight evidence of the existence of a meteor-stream which may possibly stand in some sort of connection with the Pons-Brooks comet. From an examination of all the available material of published meteor-tracks in the interval Dec. 5–8, I find, that after excluding those manifestly emanating from the well-known and active radiants in Andromeda, Gemini, and Taurus, there remain twenty-three meteors observed by Heis on Dec. 8, — about two-thirds of them in 1847, and the rest in 1855, 1857, and 1867, — and ten meteors observed at Vienna, Dec. 7, 1868; all of which indicate a strongly marked radiant in Draco. From these data I have carefully determined the position of this radiant, as follows: —

	R. A.	Decl.	Long.	Lat.
10 meteors on Dec. 7,	198.0°	+72.0°	135.0°	+65.6°
23 meteors on Dec. 8,	190.0	+69.7	137.2	+62.4

and from these I derive the following orbits, to which I add for comparison that of the Pons-Brooks comet.

	Meteors of		Pons-Brooks comet.
	Dec. 7.	Dec. 8.	
T = Perihelion passage.	Dec. 28.	Dec. 23.	1884. Jan. 25.82.
Long. of perihelion .	44.5°	55.1°	93° 21′
Long. of node . . .	256.1	256.3	254 6
Inclination	68.5	72.7	74 3
Log. per. dist. . . .	9.9600	9.9784	9.8894
Eccentricity	–	–	0.9550

The resemblance is thus not sufficient to give any considerable probability to the hypothesis of an intimate relation. On the other hand, the position of the radiant from present data is too uncertain to enable us to pronounce against that hypothesis.

The differences in inclination and longitude of perihelion are not greater than are due to uncertainty in the observed radiant points: the T and the node are, of course, of no significance in the comparison. The descending node of the comet's orbit lies at the distance 0.200 inside the earth's path, and the difference of the perihelion distance of the comet and the meteors is about 0.15. There is nothing in our present knowledge of the dimensions of meteor-streams, or of the nature of their relations to comets, definite enough to render such a breadth as is here implied evidence against a possible connection. On the whole, therefore, it appears desirable that meteor-observers should give close attention to the radiant in question about the date of the earth's passage through the plane of the comet's orbit, Dec. 5 to Dec. 7. Observations this year are likely to prove especially instructive on account of the proximity of the comet, which passes the node only a few weeks later.

S. C. CHANDLER, Jun.

Harvard college observatory,
Nov. 12, 1883.

Prize-essays on the experimental method in science.

Dr. Maurizio Bufalini, an Italian *savant* who died nearly ten years ago, left provision in his will for the payment of a prize to the person presenting the best essay on the subject of 'the experimental method in science' to the section of medicine and surgery of the Royal institute of higher studies at Florence. The essay must be written in Latin or Italian, and be presented to the chancellor of the section of medicine and surgery on or before the 31st of October, 1884. The prize is five thousand francs.

The institute has declared that all persons are at liberty to compete for this prize; and accordingly the representative of the Italian government, acting under instructions from that government, forwarded to our Department of state a programme giving in detail the subject proposed for the essay, and the conditions to be followed by the competitors, with a request that it be brought to the attention of Americans. The programme has been forwarded to the Bureau of education by the Department of state, and will be published as a bulletin as soon as practicable. In the mean time, such information, relative to the matter, as the Bureau of education possesses, may be obtained by addressing Gen. Eaton, commissioner of education, Washington, D.C.

CHARLES WARREN.

Bureau of education, Washington,
Nov. 9, 1883.

The model of Architeuthis at the Fisheries exhibition.

In the number of SCIENCE for Nov. 9, you have copied without correction a photograph of part of the London International fisheries exhibition, which shows my model of Architeuthis wrongly put together. For convenience of packing, the tentacular arms were made to take apart in three pieces; but, when the model was set up, the basal and terminal pieces were put together, making the tentacles ten feet too short. The man who had charge of the work, not knowing what to do with the remaining pieces, stuck them in at the sides of the mouth, thinking that he might find in some other box a pair of terminal clubs to put on them. In this way the model was left at the opening of the exhibition, until some visitor happened to notice the mistake, when, I believe, the extra pair of arms was taken out, leaving the tentacles still too short.

J. H. EMERTON.

New Haven, Nov. 11, 1883.

A strange sassafras-leaf.

The observations upon the sassafras-leaves — a report of which appeared in Science, no. 36 — have been continued through the year, with results which do not differ materially from those already given. Three other forms, however, have been found, which are given in the accompanying outline-engravings. Fig. 1 shows a peculiar modification of the three-lobed form, and differs from it in having the main central lobe reduced to a slightly raised emarginate end to the leaf. At first sight it seemed as if the leaf had lost its middle lobe by some foraging animal; but the absence of any roughness in the outline, and other characteristics of the edges, preclude this view. The form shown in fig. 2 helps to confirm the above view. In this we have a three-lobed form, with the lateral lobes unequal, and the central and upper portions of the leaf inverted heart-shaped (obcordate). The mid-rib has stopped short, and divided into two equal parts, which run to the tips of the two diverging lobes. If this failure of the mid-rib to extend had taken place earlier, a leaf might have been produced similar to the one shown in fig. 1.

The most interesting of the three new forms is shown in fig. 3. Here we have a happy combination of the three-lobed and the 'mitten' form. The manner in which this has been accomplished is simple, and is fully shown by the outline given. The middle lobe has become lobed upon one side, — a 'thumb' has formed; and, were the lower portion of the leaf removed, it would leave a 'mitten' of good shape. The whole framework of the leaf has become somewhat distorted: the mid-rib does not take a direct course; and the lower lobes are neither equal, nor at the same distance from the base of the leaf.

It is due the reader to state that these three forms were all found upon the same shrub, — not a large one, — and that only a single specimen of each was discovered. These were all upon the same branch, though scattered among fifty or so of leaves of the three forms before described, and which, from their uniform presence, may be considered normal. How


3.


2.


1.

shall these deviations be viewed? Is the foliage of the sassafras passing through a period in which different forms of leaves are being tried to see which is best adapted to the surroundings? It may be that there is a tendency from the simple towards the more complex; and fig. 3 shows the form which may be finally adopted. This is a subject about which even the philosophic botanists know but little; but, when one finds these deviations from the common form, he cannot help wondering after what end the plant bearing them is striving. BYRON D. HALSTED.

The thickness of the ice in New England in glacial times.

In the issue of SCIENCE for Sept. 28, Professor Wright corrects a reported statement of what he said about the depth of ice over New England, changing 600 feet to 6,000 feet, and giving as proof the well-known fact that Mounts Mansfield and Washington show ice-action to a height *above sea-level* of between five and six thousand feet.

It seems to me that the depth 600 feet must be more nearly correct than 6,000 feet. The ice-sheet over New England must have had a thickness equal to the height of these mountain peaks above the level of the contiguous valleys. From the nature of the case we cannot well prove a greater thickness, though from theoretical considerations we may believe the ice to have been much thicker. 4,370 feet, the approximate difference between the top of Mount Washington and the Crawford House, must cover the greatest differences in elevation between neighboring valleys and mountains. The average thickness of the ice-sheet must have been much less (from this proof), possibly not more than 1,000 feet. This thickness would accord with what is believed to be the thickness of the ice to the north-westward.

The glacial striae and drift-bowlders upon Mount Washington at an elevation of 6,000 feet do not necessarily lead to the supposition that the upper ice-surface had that level in northern New England, and a greater elevation to the north-westward; for local accumulations of snow and consequent ice must have existed about the summits of the White, Green, and Adirondack Mountains, as in Switzerland and in Greenland at the present time, and have constituted the source of much of the ice which spread southward over southern New England and New York.

L. C. WOOSTER.

Eureka, Kan., Nov. 7.

Museum of the Indiana university.

In the account of the burning of the museum building of the Indiana university, given in SCIENCE for July 27, are one or two errors which need correction.

The Owen collection of minerals and fossils was not entirely destroyed. Eight large cases, including the great majority of the typical specimens of David Dale Owen, were saved. The very perfect skeleton of Megalonyx Jeffersoni was also saved.

No specimens belonging to Yale college or to Cornell university were in the museum at the time of the fire. About two thirds of the very large collection made by Professor Gilbert on the Pacific coasts of Mexico and Central America were destroyed; the remaining third having been returned to the U. S. national museum, to which institution it belonged.

A new fire-proof museum building is to be erected at once, and the restoration of the collections lost is rapidly progressing. D. S. JORDAN.

Bloomington, Ind.

THE FISH-COMMISSION BULLETIN.

Bulletin of the U.S. Fish-Commission, vol. ii., for 1882. [Edited by CHARLES W. SMILEY, A.M.] Washington, *Government*, 1883. 467 p., illustr. 8°.

IN looking over the pages of this book, we find several papers of marked scientific value, written by eminent specialists in biology and fish-culture, — articles which of themselves are sufficient to give this document a prominent place upon the book-shelves of naturalists, and to render it a valuable book of reference, especially to embryologists and fish-culturists.

The articles written by J. A. Ryder deserve prominent notice; for not only do they have an important bearing upon the subject of embryology, but they also show the importance of scientific treatment in hatching and maturing fish-eggs. The two most important papers by this author are, 1°, The absorption of the yelk in the embryo shad; 2°, Microscopic sexual characteristics of the American, Portuguese, and common edible oyster of Europe compared. Several smaller papers by the same author have especial bearing upon the successful hatching and rearing of the food-fishes of the Potomac.

The papers upon the distribution and specific character of fishes, with descriptions of new species, will be of special interest to systematic ichthyologists. A large part of the book is composed of letters of greater or less importance, written to the commissioner, mainly relating to the movements of fish in certain districts. We are of the opinion that a great many of these letters might have been left out entirely, without any serious loss to science. They might at least have been judiciously cut down, and published together as a series of notes; thus giving the important points, and omitting the great preponderance of useless words and sentences which one so frequently finds in these letters. The last article in the book is entitled, "A geographical catalogue of persons who have stated that they are interested in fish-culture," by C. W. Smiley.

Sandwiched between these various papers, we find one, which, in our estimation, is grossly unfit for a scientific publication of such a high standard. The title of this article is 'Life in the sea,' by J. B. Martens. It is a translation from the Dutch; and the author is teacher of natural sciences at the seminary of St. Nikolas, Belgium. From beginning to end, it is an absurd misrepresentation of facts, and deserves the severest condemnation. For instance: we find in the introductory paragraph the statement that "life in the sea shows still greater abundance and variety" than life on the land. We cannot understand why such an article should be translated from a foreign language at considerable expense to the commission. To say the least, it shows a lack of discretion on the part of the editor; for, were articles of a popular nature desirable, it would not be necessary to incur the expense of translating, since hundreds of popular articles, with fewer misrepresentations, and of far more scientific import, could be found in our ordinary newspapers, and published with much more credit to the commission. When, moreover, it is an open secret that there are papers of real scientific value, written by eminent naturalists, kept waiting for an opportunity of appearing in one of the Fish-commission publications by the great mass of material to be issued before them, the folly of burdening the pages of the Bulletin with material of this kind becomes only too evident.

BRIGGS'S STEAM-HEATING.

Steam-heating: an exposition of the American practice in warming buildings by steam. By ROBERT BRIGGS. N.Y., *Van Nostrand*, 1883. (Van Nostrand's science series.) 108 p. 24°.

THIS little volume is one of the latest issues in the 'Science series,' and is one of the most valuable of a collection of monographs which includes an unusual proportion of excellent contributions to science and to engineering literature. The author of the paper, Mr. Robert Briggs, who died just before the publication of this last of his many papers on the science and the arts of engineering, was well known, both at home and abroad, as one of the ablest writers in the profession. This paper was written as his last annual contribution to the proceedings of the Institution of civil engineers of Great Britain, of which great association he had long been a member.

The subject of steam-heating is here treated from a purely practical stand-point, and the paper is full of useful information. An historical introduction is given, in which the introduction of this method of heating dwellings is ascribed to the late Mr. Joseph Nason of Boston, who was a pupil of the celebrated Jacob Perkins. Later, Messrs. Walworth of Boston, Gregg and Morse and Professor Mapes of New York, Greenwood of Cincinnati, and Tasker of Philadelphia, were influential in perfecting the system in the United States.

In heating by steam, welded wrought-iron tubes are employed, united by a system of screw-threads, which have been brought to certain standard forms and dimensions peculiar to the trade. The size of the tubes, and their thickness, are also fixed in accordance with settled standards. Tables are given of these sizes. The forms of the various kinds of couplings and other uniting parts are prescribed by standard practice, and the author gives tables of their principal dimensions.

The steam-boilers in use in steam-heating are usually, in the United States, either the common horizontal tubular boiler, or that form of the so-called sectional boiler known as the 'Babcock & Wilcox.' Both of these boilers are stated to be practically safe from disastrous explosion. Probably one-half of all the boilers in use are of the first type.

The two methods of heating most in vogue are that in which 'live' steam is carried direct from the boiler to the heating-pipe, and that in which 'exhaust-steam' from a steam-engine is employed. Both systems are often in use together. Several methods of application of the former system are practised, all of which have advocates among old practitioners. Loss of heat by conduction and radiation from the heating-pipes, where such disposition of heat is likely to be objectionable, is prevented by the non-conducting coverings, such as hair-felt, porous plaster, etc.

The diffusion of heat in the apartments to be warmed is accomplished by the use of radiators. The communication of heat to the air to be warmed may be done either in the rooms to be warmed by it, or before the air enters the rooms. Direct radiation in the apartment is effected by the use either of series of pipes properly set, or of slabs of wrought or of cast iron, hollow, and strong enough to receive the pressure of steam safely. In many cases the heating-pipes are placed overhead, and this system has been found perfectly satisfactory.

Systematic ventilation is usually combined with steam-heating, and in large buildings the air-currents are produced by the action of blowing-fans. This method of heating and ventilating is often carried out upon a very extensive scale. A large office in New-York City contains 1,923,590 cubic feet of space, occupied by 1,300 people, and is heated by a system in which are used 8 boilers having 173 square feet (16 sq. m.) of grate, and 8,000 square feet (743 sq. m.) of heating-surface. The state lunatic-asylum of Indiana, at Indianapolis, contains about fifty per cent more space.

Steam-heating is now adopted in the United States for all large buildings. An appendix to Mr. Briggs's paper contains tables of the more important data in use in the computation of efficiency, etc. The book is likely to prove very useful to engineers engaged in this department of construction.

NEW-YORK AGRICULTURAL STATION.

First annual report of the board of control of the New-York state experiment-station, for the year 1882. Transmitted to the legislature, March 6, 1883. Albany, *Weed, Parsons, and company, pr.*, 1883. 156 p. 8°.

THE rapid multiplication of agricultural experiment-stations in this country during the last few years has been one of the most encouraging signs of the times to those who have at heart the advancement of agricultural science, and the application of rational and scientific methods to the prosecution of a calling which has contributed, and will in the future contribute, so much to our national welfare. Since the establishment of the first state experiment-station, somewhat more than six years ago, their number has steadily increased, until now there are seven such stations, besides some half-dozen institutions which are experiment-stations in fact, though not in name. Those who are familiar with the gain which has accrued to agriculture through the work of such stations in other countries cannot but be solicitous that the movement in our own land shall be wisely guided, and that every new station shall have a high ideal as regards the kind and quality of its work.

The first report of the New-York state experiment-station is worthy of more than a passing notice, for the reason, if no other, that it seems to enunciate a view of the duties of an experiment-station.

If we correctly apprehend the introductory paragraphs of Dr. Sturtevant's report, he holds that an experiment-station, or at least the station of which he is director, should select chiefly so-called 'practical' subjects for investigation; that is, as we understand it, subjects pertaining to the art rather than to the science of agriculture. This view has evidently been put in practice during 1882. Thus a large amount of work has been done in testing the comparative value of divers varieties of field and garden plants. Fifty-eight varieties of garden-beans have been grown; their times of vegetating, blooming, becoming edible, ripening, the number and weight of seeds produced per plant, etc., noted; and a detailed description of the botanical characters of each variety prepared. Many varieties of other garden-seeds have been compared in a similar manner; and the same is true of several varieties of maize, oats, and barley. Other subjects of a similar character are, the value, as seed, of butt and of tip kernels of maize, of whole potatoes and single eyes variously cut, of level and of ridge culture for potatoes, etc. We would not be understood as implying that all the work of the station is of this character, but it is plain that the tendency has been in this direction. The institution has been in many respects more nearly what is generally understood by an experimental farm than an experiment-station.

That the director of the New-York station should hold a view of the duties of an experiment-station differing from that generally entertained is, of course, no ground for adverse criticism, except in so far as it tends to obscure the signification of the name. Neither can it be claimed that the work done has not been well done, or is not useful; though we venture to think that much of such work must generally be published either too early to allow of its being properly verified, or too late to be of much service. What we object to is the deliberate and avowed adoption, by the largest and most liberally supported of the American stations, of what seems to us a low view of its duties to its constituents and to science, — a view which fosters the demand, on the part of the public, for a species of cheap experiments, easily and rapidly made, and of little permanent value.

An agricultural experiment-station exists for the purpose of investigating the applications of natural science to agriculture. It is primarily a scientific institution, concerning itself with the science and not with the art of agriculture, and, in our opinion, can only attain to the best and most enduring success when it keeps this fact steadily in view, and devotes its energies mainly to the discovery of new truths, and the verification of old hypotheses, in the science of agriculture. That a lower aim will prove more popular need hardly be said; and, since public institutions exist by popular favor, that favor must be secured in some way. Moreover, it is impossible to draw an exact line between experiments which advance the science and those which advance the art. At the same time, fully admitting that the work of an experiment-station ought to be guided by the desires of its constituents to a certain extent, we hold that it is equally its duty to guide and educate public opinion to the point of supporting it in undertaking work of scientific value.

We urge this, not simply because of the

advantages to science, both agricultural and to a less extent general, which would result, but because we believe such a course to be the only one which will lead to enduring popularity, or yield gains to agriculture commensurate with the outlay. We are confident, that, if Dr. Sturtevant will make it his avowed aim to do as much real scientific work as possible, the state will receive a far larger return for its outlay, and that within no long time it will acknowledge such to be the case; while the beneficial effects of such a course, in promoting an appreciation of and respect for true science among the people, would not be its least recommendation.

Agricultural experimentation is attracting increasing attention; and it seems important that a clear idea should be reached by those concerned in it of its proper aims and methods; and this can be attained in no better way than by a free criticism, on the part of all concerned, of methods and ideas which seem to them false or unwise.

HERRICK'S TYPES OF ANIMAL LIFE.

Types of animal life, selected for laboratory use in inland districts. By C. L. HERRICK. Part i., *Arthropoda.* Minneapolis, 1883. 33 p., 7 pl. 8°.

THE author says in the preface, that the notes which this work contains are only a small part of the material collected some years ago for a 'Laboratory assistant for western students, arranged upon quite a different plan.' During the delay in completing the proposed work, the great need of it has been in a measure supplied by recent works; but as these treat chiefly of marine forms, or such as require dissection, he has 'thought best to place at the disposal of students and teachers in summer science classes' his notes on such types as can be studied, while living, under the microscope. The types selected are the larva of Corethra, Canthocamptus, and Gammarus, which are described, without directions to the student, or explanations of methods of work.

A text-book of this kind ought to be clearly written, and accurate, a model for the student: but Mr. Herrick's work is far from this, and no better than we might expect to find the rough notes of the student in a 'summer science class.' The description of the heart of Chironomus, on p. 7, is throughout almost or quite unintelligible, and ends with the statement that 'the last chamber is closed behind, and has the ostia quite a distance beyond.' On p. 25 we have the opening of the green or antennal gland of Gammarus described as 'an auditory or other sensory organ;' and on plate 8, an antennula, or first antenna, figured, for comparison, as the 'second antennae of prawn, with auditory sac and secondary flagellum.' The Copepoda are Mr. Herrick's specialty, and so we naturally turn to the chapter on Canthocamptus for better work: but in the first paragraph we are told that the Copepoda are divided into three sections, — Gnathostoma, having 'the mouth-organs in the form of jaws;' while 'the other sections, Poecilostoma and Siphonostoma, have the mouth-parts more or less modified for piercing or sucking.' The student may search long and unsuccessfully to discover what the 'Poecilostoma' may be. In this chapter, also, we naturally look for some account of the 'heterogenesis' of which Mr. Herrick has written elsewhere, and find the following: —

"The young of Canthocamptus become fully developed sexually before they assume their final form; and it is not unusual to find females bearing egg-sacs which are not only much smaller than the parent, but with considerable differences in the various organs. This sort of heterogenesis is not uncommon among lower crustacea, for the mother may differ much from the young till after they have themselves produced young."

Grammatical, verbal, and typographical errors so abound that it is needless to point them out. The illustrations, engraved by the author himself, are for the most part far from accurate, and very rude.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

ASTRONOMY.

Photographing the solar corona without an eclipse. — Dr. Huggins has continued his experiments on this subject during the past season. He has made use of a fine seven-and-a-quarter-inch speculum by the late Mr. Lassell (loaned for the purpose by Miss Lassell). Three inches and a quarter of the central portion only are employed, the light being received a little obliquely, so as to throw the image to one side, as in the Herschellian telescope, thus avoiding a second reflection. The absorbent screens of potassic permanganate, or blue pot-glass, have been dispensed with, and an emulsion, prepared specially for the purpose by Capt. Abney, and containing only chloride of silver, has been generally used for the sensitive plate. This film is said to be sensitive only to rays between h and H, or at least to be only slightly affected by rays of either higher or lower refrangibility. Between April 2 and Sept. 4, fifty plates have been exposed on fifteen different days; and all of them are said to show a more or less distinct coronal appearance around the sun.

The plates have been put into the hands of Mr. Wesley, the celebrated engraver, who made the magnificent plates of Mr. Ranyard's Eclipse volume; and he has prepared for each day a drawing of what he could make out on all the plates taken on that day. "This was desirable," as Dr. Huggins says, "because, whenever sufficient duration of sunshine permitted, photographs were taken on silver-bromide films as well as on silver-chloride plates: some photographs were taken with the sun screened off by a brass disk (close to the plate), others without it: also photographs were taken with the sun in different portions of the field. As a rule, Mr. Wesley has introduced into his drawings only those coronal features which were common to all the plates taken on that day."

Four drawings were presented, each of them showing incontestibly details belonging to the lower portion of the corona. The paper was presented to the British association. — (*Brit. journ. phot.*, 1883, 575.) C. A. Y. [380

Saturn. — Dr. William Meyer of Geneva gives the results of a large series of measures of Saturn and his rings. The measures agree very well with those taken in 1880. He also determined the position of the belt in the southern hemisphere of the planet. Encke's division was observed several times, and its position seemed to be nearer the exterior edge on the left than it was on the right ansa. On one occasion the ball seemed of a grayish-blue tint, while the ring was glittering white in color. — (*Astr. nachr.*, 2,517.) M. McN. [381

MATHEMATICS.

Equations of equilibrium. — M. Appell remarks that the analogies between the equations of equilibrium of a flexible and inextensible thread, and the equations of motion of a point, have long been noted, but that no one has put these equations of equilibrium into their canonical form, which would permit the application of Jacobi's principles. M. Appell considers first the case of a free thread acted on by forces possessing a potential, and transforms the equations of equilibrium into forms analogous to those giving the motion of a point. He next introduces the notion of generalized co-ordinates, q_1, q_2, q_3, replacing x, y, and z. The transformations made here are quite similar to those given by Jacobi, in his *Vorlesungen über dynamik*. The author finally studies the position of equilibrium of a thread acted upon by the same forces as before, but constrained to lie upon a given surface. — (*Comptes rendus*, March 12.) T. C. [382

Parallel surfaces. — Mr. Craig gives expressions for the ratio between the corresponding elements of area on a given surface and its parallel. The relations between corresponding elements of length, and the relation connecting the measures of curvature on both surfaces, are also derived. The area of the parallel to the ellipsoid is obtained as the sum of the areas of the given ellipsoid, a certain derived ellipsoid, and a sphere whose radius is the modulus of the parallel surface. — (*Journ. für math.*, 1883.) T. C. [383

ENGINEERING.

Simple and compound engines on short routes. — Mr. Boulvin has determined a series of formulas expressing the relations between size of vessel, weights carried, and distances traversed, and the weights of the simple and the compound engine, and finds, that, for short routes, the best form of engine is the single cylinder rather than the compound. He finds that for lines from twenty to sixty miles in length, as those from Dover to Calais and from Ostend to Dover, a gain of a knot an hour may be obtained by the use of the simple engine instead of the compound, in consequence of the saving in weight of machinery. On long routes the economy is on the side of the compound engine, in consequence of the saving in weight of fuel. The later practice of English constructors has been in accordance with this result, and with the principles involved in the work of Mr. Boulvin. He constructs curves showing the equations graphically, and illustrates their use by examples. — (*Ann. trav. publ.*, xli.) R. H. T. [384

Transportation by steamers on the Rhone. — Mr. F. Moreaux has investigated the conditions of transportation by steam on the Rhone and other fast-running and shallow rivers, and has incidentally developed a new formula for the resistance of vessels, which he applies in his study of the best methods of transporting merchandise.

He takes an expression of the form

$$R = K_1 S' + K_2 \times \frac{l}{p} \times S'',$$

in which R is the resistance, K_1 and K_2 are numerical coefficients, S' and S'' are the areas of the middle body and of the tapered ends of the vessel: l and p are the length and the breadth of these ends. The values of the coefficients vary, according to stated conditions, from 0.10 to 0.22 for K_1, and from 0.48 to above 2 for K_2. They can only be used, evidently, in cases in which these conditions are definitely known. Where used as by Mr. Moreaux, however, they give very satisfactory results. The formula is applied to a river-navigation, now conducted largely with steamers about 135 metres long, 7 wide, 1 metre in draught, with 8 square metres area of immersed midship section, 1,100 square metres area of wetted surface, and 900 tons displacement. Their engines are of 1,150-horse power, and their speed is about 4½ metres per second. The current is, in places, nearly 4 metres. Mr. Moreaux concludes that the best system for such river-transportation is that in which is used what he calls the '*Bateau mixte a ancres*,' which is fitted as a towboat, but which is also supplied with anchors of peculiar form and of great holding-power, by which the tug may be held at the head of a rapid, and then, by hauling in a tow-line attached to the tow, bring the latter through into still water. Two such boats sometimes act alternately, the one hauling, while the other is getting a new position ahead. The advantages thus secured are, that the propelling craft is not detained at either end of the line of transportation; that transshipment and the breaking of bulk are avoided; that the rapids are surmounted with comparative ease; that canal-boats are thus transportable from river to canal, and the reverse, making long trips through river and canal, and thus saving expense of repeated handling of merchandise. This system is proposed for use between Arles and Lyons. The author proposes the connection of Arles and Marseilles by a canal, and the continuation of this system through the waterway thus formed. — (*Mém. soc. ing. civ.*, April.) R. H. T. [385

AGRICULTURE.

Hill-culture of potatoes. — Experiments by Wollny having led to the conclusion that hill-culture was superfluous, or even injurious, on light soils, Schleh has made experiments with potatoes which in general have corroborated Wollny's conclusion. — (*Biedermann's centr.-blatt.*, xii. 483.) H. P. A. [386

Proteine of maize-ensilage. — Stutzer finds, that, in the preparation of ensilage from maize, the proteine is largely broken up into products which are not precipitated by copper hydrate, and which are probably of inferior nutritive value. Jordan has made the same observation in experiments at the Pennsylvania state college. — (*Ibid.*, xii. 497.) H. P. A. [387

Nitrification in the soil. — Nitrification is dependent on the presence of oxygen, and Schlösing has shown that a diminution of the amount of oxygen present decreases the rapidity of the change. Such a diminution of the amount of oxygen in the soil is effected by the presence of organic matter, which unites with it, forming carbonic acid, and thus acts, as Déhérain and Maguenne point out, to moderate the rapidity of nitrification, and so to prevent a loss of nitrates in the drainage-water. The same authors explain in this way the greater richness in nitrogen of untilled land, and claim that the presence of organic matter is necessary in order that the soil shall gain nitrogen from natural sources. — (*Ibid.*, xii. 506.) H. P. A. [388

MINERALOGY.

Albite. — Des Cloizeaux gives the results of the optical examination of a large number of specimens of albite. Although this mineral is the most constant of all the felspars in its chemical composition, its variations in optical properties are great, and dependent upon the homogeneity of the material, the number and arrangement of the twin lamellae, and, without doubt, upon the circumstances of temperature and pressure at which the crystals were formed. The following are the properties of the purest and most transparent crystals, which may be regarded as normal: the plane of the optic axes is normal to a surface truncating the acute edge between oP and $\infty \breve{P} \infty$, and making an angle of 101°–102° with the base; the acute bisectrix is always positive, and nearly normal to the edge oP and $\infty \breve{P} \infty$; the axial angle for red in oil is about 80°–85°, ordinary dispersion $\rho < \nu$; the obtuse bisectrix is always negative; the axial angle for red in oil is about 104°–106°, ordinary dispersion $\rho > \nu$; basal sections give for the angle of extinction 2°–4° on either side of the plane of twinning; on the brachypinnacoidal section the angle of extinction is nearly 20°. The results of the examination of thirty-four different varieties of albite are given, many of them accompanied by chemical analyses. — (*Bull. soc. min.*, vi. 89.) S. L. P. [389

METEOROLOGY.

Meteorology in China. — Dr. Doberck of the Hong Kong observatory proposes to study the climatology of the region, to determine the magnetic conditions, and to investigate the magnetic attraction of various mountains and hills in the vicinity. It is probable that he will endeavor to arrange for the receipt of regular reports from neighboring observatories with the object of making weather forecasts. — (*Nature*, Sept. 27.) W. U. [390

Hygrometer studies. — A good hygrometer which can be used in place of the wet- and dry-bulb thermometers, and be equally convenient, but more accurate in cold weather, is one of the needs of practical meteorology. Comparative observations of the psychrometer and the improved hair hygrometer, as manufactured by Höttinger, have been made at Breslau by Dr. Galle since 1880. As a result, he states, that if the saturation-point is determined at intervals of from eight to fourteen days, and the instrument carefully cleaned when necessary, the relative humidity can be obtained with as great accuracy as with the psychrometer, and in winter with greater accuracy. Unfortunately, there still remains in the instrument the liability to unexpected changes in the saturation-point, and in the working of the mechanism; so that a psychrometer must be at hand for the purpose of comparison. — (*Preuss. stat.*, lxxi.; *Ergeb. met. beob. königl. met. inst.*, 1882.) W. U. [391

GEOGRAPHY.

(Asia.)

Investigations in Thibet. — At the suggestion of Gen. Walker, geodesist-in-chief to the survey of India, an interesting exploration is about to be undertaken by one of the pundits attached to the survey. This pundit was a companion of the famous Nain Singh, and succeeded, in the midst of a thousand obstacles in the eastern part of Thibet, in recording and preserving his itineraries, and obtaining many latitude observations. Thanks to his researches, an area three times as extensive as France can be to a certain extent corrected, and mapped with tolerable accuracy. The great Thibetan problem as to the relations of the Dzang-bo River are probably settled by his work, from which it would appear that this belongs to the head waters of the Brahmaputra rather than (as formerly supposed) to the Irawadi River. — (*Bull. soc. géogr. Mars.*, June.) W. H. D. [392

(Africa.)

Sociology of the Kabyles. — M. Sabatier, who has long been a resident of Algeria, and served as a judicial officer among the Kabyles, gives the following details as to their civil and social organization. These people, sharply distinguished from the Arabs, are of the Berber race, and number about three hundred thousand.

The villages are associated in governmental groups of not more than twenty settlements each. Such a group is termed a kabila. The supreme chief, or magistrate, of the kabila, is the amin. There is always another chief called ukil, charged with defending the rights of the minority of the electors. In each kabila the karuba, of forty or fifty male adults, forms an electoral body. The right to vote, or the attainment of individual majority, is decided in a singular manner. A thread is measured off, which, when doubled, shall exactly encircle the neck. This thread, made single, is then passed from the occipital base of the head over the cranium; and, when the other end reaches only to the chin, the development of the head is supposed to be complete, and the individual politically mature. This ordinarily happens about the age of fourteen. Each karuba has a distinct jemmáha, a sort of municipal council, presided over by a tamen. The tamens, all together, form the general council of the kabila, which, with the ukil and amin, forms the administration. The rights of minorities in each karuba are carefully guarded. The minority is called the saf, and may elect a chief, who serves one day to redress grievances, after which he retires to his private station. They have no prisons. The grand council may banish a criminal, destroy his house, burn his clothing, or order him, as a last resort, to be stoned to death. The council directs all municipal matters. If hostilities break out between two villages, and blood is shed, neighboring villages generally intervene by proclaiming anaya. This anaya is an invitation to cease hostilities, which the combatants dare not disregard. Were it disregarded, it would be considered an extreme insult to the safs of the peace-making villages, which all other village safs would be bound in honor to avenge.

The family organization of the Kabyles is unique. There is, in fact, no family, in our sense of the word. Such as there is, is terminable conditionally. A Kabyle who desires a wife says to her father and brother, 'You must sell me this girl.' The price is debated, and an agreement made before witnesses. Fifteen to forty dollars is the usual range. The money paid, he gives a dress to the bride, and all is done. The wife may be sent back without explanation, and the price reclaimed from her family.

If the wife quarrels with her husband, she may call upon a third person to proclaim anaya between them. The husband may then not only reclaim his payment to her family, but set on her head a price, often exorbitant, which any other lover must pay into his hands before he can take her to wife. The woman is then said to be 'retired from circulation.'

Children, if boys, are held in honor, representing one more vote and one more gun; girls must shift as best they may; at least half the Kabyle women live by gathering sweet acorns.

Kabyle law regulates the disposition of property. If a peddler possesses a field which he cannot use on account of the demands of his business upon his time, the law obliges him to plant it with olives. The property in such matters is wonderfully divided up: one man may own the fifth part of a field; another, a fifth of the crop of olives, or a third of the crop of figs; still another, the third branch of the fifth olive-tree, or that branch which points to the east.

In Kabylia the discoverer of a spring of water, even if situated in the field belonging to another person, owns the water from it. This tends to encourage the search for water, the most important element in that arid region. The Kabyles are excellent agriculturalists. If there is a spot of earth in a chasm, a Kabyle will descend by a rope and cultivate it. They are extremely industrious, and work in concert. In the Kabyle country, land suitable for cultivation is worth eighty dollars an acre, while in the Arab districts it does not average four dollars in value per acre, — a difference illustrating the respective characters of the two races. The question of ousting the Kabyles from the land they cultivate, to make room for French colonists, is being discussed in France: so it would seem that the Americans are not the only people capable of robbing the aborigines. — (*Rev. géogr.*, June, 1883.) W. H. D. [393

BOTANY.

Columbines. — Grant Allen (*North-American review*, September) traces several of the steps by which the typical ranunculaceous flower has been modified to form that of Aquilegia and the other more highly specialized genera. The more important are the elongation of the petal, which "is just the petal of the buttercup, with the tiny depression or hollow of the nectary prolonged backward into a tubular spur," as a protection against small, thieving insects; and the reduction in the number of carpels, without a corresponding lessening of the ovules, which insures a more certain fecundation of the latter. The fact that A. canadensis is even more perfectly adapted to pollination by humming-birds than by bees, seems, however, to have escaped him. Though more greatly modified, the hooked spur of European columbines is in no wise more perfectly adapted to the end it is to serve than the straight spur of American species. In his zeal for demonstrating the correlation of highly specialized forms and colors in entomophilous flowers, the writer is also led to ignore such species as the common European Aconitum lycoctonum, which, with the structure of its immediate relatives, has the much less specialized yellow color of those lying lower in the scale.

Dr. Gray (*Bot. gazette*, September) calls attention to the longest columbine (A. longissima), a species from northern Mexico, with spurs four inches or more in length, and clearly adapted to profit by the visits of some long-tongued hawk-moth like Amphonyx antaeus, which occurs in the south-west, and has been found by Mr. Henshaw to have a proboscis certainly five inches and three-quarters long. It should be stated that all of our American columbines that have been studied, whether fertilized by bees, moths, or birds, are strongly protandrous, like the European species. — W. T. [394

Symbiosis. — Dr. Sedgwick gives a well-written synopsis of the results of the more important recent studies concerning the occurrence of chlorophyll in animals, and its significance. These seem to show that the so-called 'animal chlorophyll' has no actual existence, being in every case (possibly excepting Hydra and Spongilla) connected with a vegetable structure living in the tissues of the animal. This association of plant and animal, in the mutual benefits derived, is held to be somewhat different from the so-called parasitism known in lichens; but it is hard to see in what important respect the two cases differ. — (*Pop. sc. monthly*, Oct.) W. T. [395

ZOÖLOGY.

Coelenterates.

The anatomy and histology of Porpita. — A diffused nervous system, made up of a plexus of scattered ganglion-cells connected with each other by nerve-fibres, and similar to that described in the Medusae and Actiniae by the Hertwigs, and in the Hydroids by Jickeli, Lendenfeld, and others, has been described by Chun in Velella. Conn and Beyer have independently discovered the same structures in Porpita; although they express some doubt whether they are really nerve-cells, rather than some form of connective-tissue corpuscle without any nervous function. They incline, however, to the belief that the close resemblance which they bear to cells which have been found in the Medusae and Actiniae justifies us in regarding them as a very primitive nervous system.

The cells in question are, in Porpita, ectodermal; and sections show that they lie actually in the ectoderm-cells, outside the supporting layer and the layer of muscles. They are always found in connection with the muscles, and they are most abundant where the muscular system is most developed. They are bipolar, tripolar, or multipolar; and their processes could be traced to a considerable distance. Their distribution is as follows: they lie wholly in the ectoderm; and their fibres, after running for a considerable distance beneath the outer ectoderm-cells and immediately upon the muscle-layer, finally penetrate this layer, and are lost. The whole of the upper surface of the animal is supplied with them, somewhat sparsely toward the centre, but much more abundantly towards the edge, and especially in the velum. The under surface of the velum has also a rich supply, and the tentacles also contain great numbers; but towards the centre of the lower surface of the disk they gradually disappear, and none could be found upon the nutritive zooids. They are everywhere few in number, as compared with the ectoderm-cells, and they are very irregularly distributed. There is nothing like a central nervous system, and no union of the cells into a nerve-ring could be made out. Conn and Beyer also describe a number of so-called 'sensory organs,' which are placed in pockets, or pouches, around the edge of the velum. Each of these is filled with large and highly modified ectoderm-cells, which the authors regard as sense-cells. They have no connection with the ganglion-cells. — (*Stud. biol. lab. Johns Hopk. univ.*, ii. 433.) W. K. B. [396

Mollusks.

Visual organs of Solen. — Dr. Benjamin Sharp had been led to believe that Solen ensis and S. vagina, the common razor-shells, are possessed of visual organs, by observing that a number of these animals which were exposed in a large basin for sale in Naples retracted their siphons when his hand cast a shadow over them. Repeating the experiment at the zoölogical station, he became convinced that the retraction was due to the shadow, and not to a slight jar which might have been the cause. Upon examining the siphon, he found as many as fifty fine blackish-brown lines or grooves between and at the base of the short tentacular processes of the external edge. When a vertical section of these pigmented grooves is made, the cells of which they are composed are found to be very different from the ordinary epithelial cells of the surrounding tissue. The pigment-cells are from one-third to one-half longer than the latter, and consist of three distinct parts. The upper ninth or tenth part of each cell is perfectly transparent, and is not at all affected by the coloring-matter used in making the preparation; the second part is deeply pigmented and opaque, and forms about one-half the cell; while the remainder consists of a clear mass, which takes a slight tinge when colored. This portion contains a well-defined nucleus filled with granular matter, and is probably the most active part of the cell. These retinal cells, if so they may be called, resemble those of the very primitive eye of Patella. The value to the Solen of an organ which would enable it to detect the shadow of approaching objects as it lies embedded in the sand, with the end of the siphon protruding, must be evident; and the structure of the cells described bear sufficient relation to those of the eyes in Patella, Fissurella, and Haliotis, to make it highly probable that they constitute true primitive visual organs. — (*Acad. nat. sc. Philad.*; *meeting* Nov. 6.) [397

Organization of chitons. — A second part of Dr. Béla Haller's valuable investigations of the chitons of the Adriatic has appeared. It is illustrated with three double plates; and the species which have served his purposes are Chiton siculus and C. laevis. This part is devoted especially to the finer structure of the buccal muscles, of the parts surrounding the mouth and below the radula, and the minute structure of the branchia. He confirms the conclusion of Dall in 1879, — that the separate branchial tufts correspond each to a distinct branchia, instead of to the old cyclobranchiate theory, — and adds very materially to our knowledge in each of the above-mentioned directions. The author wisely refrains from much theorizing, as no group of equal rank exhibits more polymorphism than this, and no general rules can be laid down with confidence from the examination of two species. — (*Mittheil. zool. inst. Wien*, v. heft 1.) W. H. D. [398

Crustaceans.

Trilobites from the Hamilton rocks of Pennsylvania. — Professor Angelo Heilprin has found in a small collection of invertebrate fossils obtained from the Hamilton rocks of the vicinity of Dingman's Ferry, Pike county, Penn., a complete specimen and several tail-pieces of Phacops bufo, and several well-preserved fragments of Homalonotus Dekayi. The determination of these species is of peculiar interest, inasmuch as it had been asserted that no trace of trilobites could be discovered in the rocks of this series. — (*Acad. nat. sc. Philad.; meeting* Oct. 30.) [399

VERTEBRATES.

Origin of fat in cases of acute fat-formation. — The chief part of this paper by Lebedeff is taken up with a discussion of the origin of the fat formed or deposited in the liver in phosphorus-poisoning. The author criticises at length the different theories of the origin of fat, under both physiological and pathological conditions. He does not admit the generally accepted theory of Voit, that the fats of the body form one of the products of the destruction of proteids, and gives some calculations showing the insufficiency of such an hypothesis to account for the amount of fat found in the liver and other organs after poisoning by phosphorus. His own view is, that, under normal conditions, the animal fat is derived directly from that taken into the body as food, while, in pathological cases, — fatty infiltration of the liver, for instance, — the fat originates from that already stored up in the body. The change in the chemical composition of the blood, produced by phosphorus, causes the fat in the subcutaneous connective tissue to pass into the blood, whence it cannot be removed on account of the diminished supply of oxygen, which is one of the results of phosphorus-poisoning, and therefore accumulates in the liver. Lebedeff has shown in a former paper, that when a dog is starved until all fat has disappeared from its tissues, and is then fed on foreign fats — linseed-oil, for example — and some proteids, there is a large accumulation of the strange fat in the body. Similar experiments were again made, with the addition that the animal was afterwards poisoned with phosphorus. Chemical analysis of the fat of the liver in such cases showed that it also, like the subcutaneous fat, contained a large proportion of the foreign fat. This fat could not have resulted from the destruction of proteids of the body, but must have been derived from fat already stored up in the body before poisoning, especially the subcutaneous fat. Lebedeff also made chemical analyses of the fats contained in the milk of the cow, woman, and rabbit, and compared them with the fats of other parts of the body. He finds that the 'fat of milk has no analogue in the body,' and consequently is not derived directly from these fats. He does not believe, however, that this fat results from proteid metamorphosis. The increase in the fat of milk, that takes place after feeding with meats, is owing, he thinks, to the fact that the albuminous material taken serves to emulsify the fats, and thus insures an easier passage from the blood. He comes to the conclusion that the fat of milk is directly influenced by the nature of the fat taken as food, and gives the results of some experiments demonstrating this fact. With regard to the origin of the milk-fat, his statements are not very satisfactory. It is derived directly, in the first place, from the fat of the mammary glands, with which it agrees in composition. This, in turn, is formed, he thinks, from the fats taken as food, or, in the case of starvation, from the fats stored up in the body. — (*Pflüger's archiv*, xxxi. 6.) W. H. H. [400

Mammals.

Vaso-dilators of the lower limb. — In previous papers, Dartre and Morat have shown that the view which was generally held of the distribution of the vaso-motor nerves — that the vaso-constrictors take their course through the sympathetic, the vaso-dilators through the cerebro-spinal nerves — is not true for the cervical sympathetic. They succeeded in demonstrating in it the presence of vaso-dilator nerves for the cheek, lips, etc. In the present paper they give the results of similar investigations upon the lower segments of the sympathetic, and the vaso-motors of the lower limbs. In order to estimate the vaso-motor effects, two methods were used. A manometer, or sphygmoscope, was connected with the femoral artery below the origin of the profunda; and, at the same time, the color-changes in the skin of the toes were noticed. Young dogs with little or no pigment on the feet were used. They first investigated the effect of stimulation of the peripheral end of the divided sciatic. In all cases the manometer showed a rise of arterial pressure, indicating that vaso-constriction had taken place; but, together with this general vaso-constriction of the blood-vessels, it was found, in some cases, that the balls of the toes were congested, showing local vaso-dilatation. If, instead of the sciatic, the abdominal sympathetic was divided at the level of the fourth lumbar ganglion, and the peripheral end stimulated, the same result was reached, — a general constriction of the arteries, together with a local dilatation of the skin of the toes. The latter phenomenon, as in the first experiment, was not constant. When the sympathetic was stimulated still higher, just below the diaphragm, the manometer gave a rise of pressure; but the dilatation of the vessels of the toes was more evident, and occurred in all cases. The interpretation they give to their experiments is, that vaso-dilator as well as vaso-constrictor fibres run in the sympathetic to the lower limbs; the vaso-constrictors predominate: hence the general rise of blood-pressure in the limb. The fact that the vaso-dilator effects are always obtained when the lower part of the thoracic sympathetic is stimulated, while in stimulation of the lumbar sympathetic and the sciatic this phenomenon is very inconstant, means, they think, that the vaso-dilators terminate, in part at least, in the ganglia of the lumbar sympathetic, and exercise their influence on the blood-vessels by means of these ganglia, and not through the hypothetical peripheral ganglia of Goltz. Facts of the same general import have been given before by the authors, with regard to the last cervical and first thoracic ganglia. — (*Arch. de physiol.*, 549, 1883.) W. H. H. [401

Sexual variation of Rhytina. — Drs. Stejneger and Dybowski have given in two different journals a preliminary account of their joint discovery of a remarkable variation, supposed to be sexual, occurring in the skull of the arctic sea-cow. Their conclusions are based upon an examination of five adult male and three adult female skulls. The male skulls have the zygomatic arches both absolutely and relatively wider than the female skulls. The whole central portion of the former, also, is wider than that of the latter. In the female the vertical ramus of the mandible is longer than in the male, and the posterior angles are much nearer together. It appears that these differences have long been recognized by the Eskimo. — (*Proc. U. S. nat. mus.*, v. 79 ; *Proc. zoöl. soc. Lond.*, 1883, 72.) F. W. T. [402

ANTHROPOLOGY.

The death of King M'tesa. — Col. J. A. Grant, once the guest of this renowned king of Uganda, gives credit to the report of his death, published in the daily papers of the 13th of July. Some years ago the king was suffering with a malady which the missionaries believed would terminate fatally unless an operation was performed. The king was dissuaded from this; though the Africans, as a rule, operate upon one another without fear. When Speke and Grant visited him in 1862, he was a minor, the lineal descendant of a line of thirty-five kings, which accounts for the 'blue blood' and vanity which certainly ran in the veins of M'tesa. Col. Grant alludes to the princes of Uganda, whom Stanley saw in chains, as following a custom by no means irksome, to which M'tesa himself had submitted previously to his election. The vigor with which he administered his government, and his courtesies to travellers, have given him a world-wide reputation. He raised his subjects above the ordinary scale of Africans by making them observe while travelling. He fearlessly adopted the Mahometan, and afterwards the Christian religion, by listening to the Mollahs and Christian travellers who entered his country; his previous belief having been in one supreme being and in charms. To M'tesa is greatly due the discovery of the sources of the Nile; for it was he who gave us the route from the Victoria Nyanza to Egypt, and the knowledge that we have of the people, and the flora and fauna, of equatorial Africa. The army and navy of this king is said to have numbered 125,000 soldiers. His government was carried on by daily durbars, where several hundred chiefs of districts assembled with their followers to hear the eloquence of the prime-minister and members of the government. — (*Proc. geogr. soc. Lond.*, Aug.) J. W. P. [403

The tribes of the Cunéné, S. W. Africa. — The earl of Mayo, having spent the best part of a year in Mossamedes and its vicinity, gives us the benefit of his experience. Not much new information is conveyed about Portuguese rule; but a very interesting account is given of a colony of Boers, at Humpata, who, with their wives, children, and cattle, had trekked from Pretoria in the Transvaal, and reached his place after seven years' wandering. The negro tribes encountered were: 1. The Mundombes, holding the region from Mossamedes to Capangombe, at the foot of the Sierra de Chella. They have a language of their own, and belong to the Bantu family. They are large cattle-keepers, and are the native porters who carry travellers' luggage as far as the top of the Sierra de Chella. 2. The Munhanecas and Quipongos, tribes who inhabit the country around Humpata, Huella, and three days eastward. They are of the Bantu stock, cultivate the soil, and are armed with poisoned arrows, assegais, and knobkerries. 3. The Chibiquas, who live on the west slope of the Sierra de Chella, north of the Cunéné River. They belong to the Damara race, intermixed with Ovampos, whose language they speak. They capture the elephant by prodding the hind-feet so as to sever the muscles. The animal, thus brought to a standstill, is despatched with assegais. 4. The North Ovampos, who speak a dialect of the Damara language, and cultivate each an hereditary farm, having no communal farming, as the Hahé and Huilla natives. — (*Proc. geogr. soc. Lond.*, Aug.) J. W. P. [404

The Lolos of central China. — There is one indigenous tribe or people, now completely enveloped by a Chinese population, which has successfully resisted the wave of Chinese encroachment. They are termed 'Lolo' by the Chinese, 'Lo-see' and 'Ngo-see' in their own dialect. They inhabit a mountainous region on the Yangtsze, between 27° and 29° north. They make incursions into Chinese territory for blackmail and ransom, which they call 'rent,' and hold in slavery the Chinese then captured. We have the word of Marco Polo that "they are a tall and very handsome people, though in complexion brown rather than white, and are good soldiers." They never intermarry with the Chinese, even the Chinese female captives being given to the male captives as wives. Mr. Baber, who has closely studied these people, seeks to identify them with the *Colomon* of Marco Polo, and in the course of his argument makes some interesting statements respecting their burial-customs. They possess the art of writing; and Major-Gen. Mesny, of the Imperial Chinese army, some years ago obtained a thick folio manuscript from a tribe near Chenning, in Kuei-chou (25° north, 105° 40′ west). The work is bound in goat-skin with the hair on, and is written in the ordinary Lolo script, with illustrations of a crude and primitive nature, depicting human figures, animals, and plants. Mr. Baber pays a just tribute to Baron v. Richthofen and Col. Yule, in stating his conclusions respecting the Lolos. — (*Proc. geogr. soc. Lond.*, Aug.) J. W. P. [405

Ethnology of Timor. — In a letter addressed to Sir Joseph Hooker, in 1880, Mr. H. O. Forbes wrote from Sumatra, offering, if some assistance could be forwarded him, to attempt an expedition to Timor-laut. The British association granted the needed funds, and the trip was made. This island must not be confounded with Timor, lying to the south-west. A large collection of crania and culture-objects was made, and a vocabulary of several hundred words compiled. Among their customs described are their methods of dressing the hair, the clothing and ornamentation of the body, their agriculture, meals, fishing, armor, marriage, care of children, mourning, inheritance, oaths, government, slavery, physical characteristics, intellectual and moral qualities, pastimes, music, and calendars. Commenting on the paper, Prof. Flower stated, that, of the twelve crania, eight were brachycephalic, and of decidedly Malay type; one was dolichocephalic, prognathous, and with large teeth, indicating Papuan or Melanesian affinities; and the other three were more or less intermediate. Nearly all showed signs of artificial flattening of the occipital region.

Mr. Keane remarked that Mr. Forbes confirmed the prevalent opinion regarding the extremely complex nature of the ethnical relations throughout the whole of Malaysia and Polynesia. In Timor-laut, Papuan, Malayan, and even Polynesian tribes had here become intermingled in diverse proportions; the result being a distinctly mixed race, such as was everywhere in this region often designated by the inconvenient term of 'Alfuro.' Timor-laut, however, seemed to present the peculiarity that the various elements had not here become so completely amalgamated as in most of the neighboring islands. Hence the remarkable phenomenon of frizzly and lank hair, brown and black complexion, very tall and very short stature, dolichocephalous and brachycephalous heads, etc., all still found side by side in the same village community. The resemblance in so many of the crania to those of the brown Polynesian race of Samoa, Tahiti, Hawaii, etc., was very striking; so that Timor-laut must have been one of the last islands occupied by this race in Malaysia during its eastward migration to the remote archipelagoes of the Pacific. — (*Journ. anthrop. inst.*, xiii. 8.) J. W. P. [406

The Mavia tribe of negroes. — Cape Delgado is on the east coast of Africa, about 11° south. Mr. H. O'Neill, H.M. consul, has made a journey inland from this point into the country of the Mavias, or Mahibas, whose existence was first pointed out by Livingstone, and who have baffled the efforts of succeeding travellers to penetrate their country. Mr. Joseph Thomson and Mr. Chauncey Maples both testify to their exclusiveness. A description of one village will serve for all. A circular belt sixty to eighty feet wide was thickly planted with trees and underbrush. At two or three points a narrow path was left for entrance, and guarded by double or triple gates. The gate is a framework of two strong uprights, deeply embedded in the ground, and strengthened by two horizontal bars about five feet apart. Two other movable horizontal bars fit, one end in a hole, the other in a niche in the uprights. A number of smaller uprights have holes burnt through both their ends, by which they are threaded upon the two horizontal bars until the framework is completely closed, when the ends are thrust into the holes and niches, and the whole strengthened by beams placed against it on the inside. The gates are carefully closed at sunset. Forty or fifty huts are built in the space, and goats and poultry take the place of the Irishman's pig in each shanty. This tribe wear immense lip rings or studs, which give to them a hideous profile. They show a great respect for the dead, and carefully tend the graves of any of their chiefs or head men. On some of these are raised mounds of clay, enclosed with a low ridge. This again had a raised framework upon it, roofed in with thatch, and the corner posts ornamented with small streamers of cloth. Mr. O'Neill appends a vocabulary of about a hundred words. — (*Proc. geogr. soc. Lond.*, July.) J. W. P. [407

EARLY INSTITUTIONS.

French and English law. — Some time ago the Institute of France proposed as a subject for competitive writing a comparison of the French and English systems of law in their history and development. An extensive work (5 vols. 8°) was forthwith produced by M. Glasson. It was accepted and 'crowned' by the academy. It is entitled *Histoire du droit et des institutions politiques, civiles, et judiciaires de l'Angleterre, comparés au droit et aux institutions de la France, depuis leur origine jusqu'à nos jours*. The book is being reviewed, and is much praised. The student who finds Reeves' History of the English law obsolete and tiresome will be glad to have a substitute for it. The writer takes up different subjects,—'the king,' 'parliament,' 'property,' etc., — and treats them separately. The sequence of events, and their relationship with one another, are by this method lost sight of to a certain extent. The method has its advantages, however; and a subject so comprehensive could hardly be treated, we should think, in any other way. It is quite impossible to bring history, with its innumerable beginnings and endings, or issues, into one continuous narrative. French history begins with the meeting of the Germans and the Romans. French institutions are, to begin with, partly German, partly Roman. English institutions are, however, almost purely German down to the period of the Norman conquest. It is in England, therefore, that we trace the development of German institutions, rather than in France. The monarchy, for example, was in France framed upon the Roman model; while in England the Teutonic model was adhered to. While we have an absolute monarchy in France, we have a very limited monarchy in England, — a democratic republic, with a monarchical head, so to speak. Feudalism is described as the result of German and Roman influences. It established itself in France, and was taken from France into England. The English were verging towards feudalism, to be sure. There was a good deal of feudalism in England before the conquest. The custom of commendation was not unknown, but it was not associated with the holding of benefices. The holding of *boc-land* under the *trinoda necessitas* resembled the holding of a benefice in later times; but the holders of *boc-land* were not vassals of a lord. Their services were due to the state rather than to the king. The king was not the universal landlord until after the conquest, when the Norman lawyers persisted in describing proprietorship as a tenancy. At the same time a great deal of proprietorship was converted into tenancy. The position of the isolated proprietor was unsafe; and proprietors very generally converted their inheritances into tenures, under the overlordship of the king or some other great lord. M. Glasson describes the various forms of tenure which existed under the feudal system, and the condition of the tenants. A large part of the work is devoted to legal procedure and judicial organization. — (*Edinburgh rev.*, July, 1883.) D. W. R. [408

NOTES AND NEWS.

The death of Dr. John L. LeConte at his home in Philadelphia on Thursday of last week, at the age of fifty-eight, removes one who has long been the leader, *facile princeps*, of American entomologists. With his death, the younger men are completely separated from the former generation of workers in this field, and they will lose a friend and teacher to whom they constantly looked. Dr. LeConte was as highly honored abroad as at home, and has been an active investigator for nearly forty years. His death occurred during the session of the National academy, of which he was a member, but was not known in New Haven until its close. We shall give in a future number an account of his services to science.

— President Arthur, in carrying out an act passed by Congress, has invited the various countries to send representatives to an International conference at Washington, the date of which is not yet fixed, to establish a common prime meridian. The governments of Austria, Norway, and Sweden, have declined; but the latter two approve of the object. Spain is favorable, but has deferred its reply. Belgium is uncertain, but Denmark and Portugal have accepted the invitation conditionally. Switzerland, Venezuela, Mexico, Turkey, Greece, China, Japan, Hawaii, Hayti, Liberia, Holland, Canada, Guatemala, Roumania, Nicaragua, and Honduras have accepted. Replies are expected from Italy, Great Britain, Russia, France, Chili, Brazil, and Germany.

— Mr. Edward Atkinson has prepared a plan for a textile laboratory and museum in Boston. He thinks that a hundred thousand dollars would be ample for the construction of a proper building, and its equipment, which should be an adjunct of the Massachusetts institute of technology. The purpose is to afford special training for young men intending to pursue textile manufacture. The first two years' course of instruction in the institute is suited as a basis for the future special study of textile manufactures; and it is in the next two years of the curriculum that special training should be followed. The first two years would ground the student in modern languages and mathematics, in mechanical drawing, in general geology and chemistry, as well as in the practical work of the physical and chemical laboratories, and will thus prepare him for entering upon the special course of textile industry. The professional studies would include geology, botany, mechanical engineering, building and architecture, mechanics, textile design in all branches, industrial chemistry, history, and political economy.

— Professor Balfour Stewart and Mr. W. L. Carpenter discussed, before the British Association for the advancement of science, the supposed sun-spot inequalities of short period. Putting aside for the time the question of true or nearly apparent periodicity, they exhibited certain results obtained by application of a method of detecting unknown inequalities in a mass of observations. Thirty-six years' observations of sun-spots were divided into three series of twelve years each. Two apparent sun-spot inequalities of about twenty-six days came out very prominently, appearing for each of the twelve years in the same phase, and to very nearly the same extent.

— A design for a new high-level bridge at Newcastle-on-Tyne has been prepared by W. G. Laws, city engineer. It shows a clear span of six hundred feet, and a clear headway above high water of eighty-two feet. The bridge will be of steel, and the cost of superstructure, foundations, and approaches, is estimated at two hundred and fifty thousand pounds.

— Sir J. Whitworth & Co. have lately completed and tested a 9-inch (23 centimetres) gun for the Brazilian government. The peculiar feature of this system is the hexagonal section of the bore of the gun. The material is compressed cast steel, which is superior to other steels in its combined ductility and tenacity, and in its perfect soundness. This gun, on trial, threw a shell of the weight of 300 pounds (136 kilograms) 7,876 yards (over 7,000 metres), and drove a steel shell weighing 400 pounds (181 kilograms) through a wrought-iron plate 18 inches (48 centimetres) in thickness; and its backing broke up a cast-iron plate supporting it, and finally buried itself in the earth. Such results are not attainable, so far as experience has yet indicated, by any other system of ordnance.

— An electric tram-car was recently tried in Paris very successfully. It was driven a distance of thirty miles in about three hours without accident or detention. The current was supplied by Faure accumulators placed under the seats, and driving a Siemens dynamo under the floor at the rate of twelve hundred revolutions per minute. The car-wheels turn sixty times to twelve thousand revolutions of the dynamo. The speed attained was five and a half to nine miles an hour, according to the gradient.

— In a paper before the British association, Professor Boyd Dawkins remarked that the classification of the tertiary rocks, sketched out some fifty years ago, and since then altered in no important degree, is out of harmony with our present knowledge, and the definitions of the series of events which took place in it has been greatly modified by the process of discovery in various parts of the world. The terms 'eocene,' 'miocene,' and 'pliocene' no longer express the idea of percentages of living species of fossil mollusca upon which they were founded; and post-tertiary, quaternary, and recent are founded on the assumed existence of a great break comparable to that separating the secondary from the primary or tertiary periods, which is now known not to exist. The author proposed a classification of the tertiary period in Europe by an appeal to the land mammalia, and since that time his definition has been found to apply equally well to the tertiaries of Asia and the Americas and to the late tertiaries of Australia. He stated that the forms of life in the rocks have changed at a very variable rate, and in direct proportion to their complexity of organization; the lower and simpler having an enormous range, while the higher and more complex have a much narrower range, and are more easily affected by the change in their environment.

—The proposed discussion on the possibility of establishing a universal time by selecting a meridian common to all nations has given rise to many suggestions more or less valuable. One of these, published in the *Journal of the society of arts*, is, that 'the simplest way of expressing this universal time would be by using Roman figures; while the civil time would be expressed by Arabic numerals, followed by a large *H* for the morning hours, and a small one for those of the evening. In fact, the hour would be expressed in a manner similar to that in use among the Russians for designating the old and new style in dates. In the same manner as they say 16/28 June, the railway time-tables would say, Arrival at Paris, XXIII./10 h. 24 m.; departure from Paris, XVI. 40 m./4 h. 04 m.; departure from St. Petersburg, VIII. 10 m./9 H. 26 m.

—At the meeting of the French academy of sciences, held Oct. 3, M. Alphonse Milne-Edwards reported the foundation of a new laboratory of marine zoölogy at Marseilles. It is to be under the direction of Professor Marion, of the Marseilles faculty of sciences.

—The periodicity of drought and floods in the Rhine district, and its connection with sun-spots, aurorae, and the magnetism of the earth, is dealt with in a work by Professor Paul Reis of Maintz, just published by Messrs. Quandt and Handel of Leipzig. The volume is entitled 'Die periodische wiederkehr von wassersnoth und wassermangel.'

— In Austria, as well as in Germany and England, systematic efforts are being made to settle the questions as to the contagiousness and heredity of tuberculosis. A circular has been sent to eight thousand medical men in Austria, requesting them to give particulars of any cases which they consider to have proved the contagiousness of the disease, and also to give the particulars of cases of supposed heredity, and of any cases in which complete cure is believed to have been effected. The determined international effort which is being made to cope with this fell disease must be regarded as one of the results of Koch's discovery of the Bacillus tuberculosis.

— At a recent meeting of the French entomological society, Dr. Laboulbène instanced a case in which dipterous larvae had been vomited by a woman thirty-nine years old, under the care of Dr. E. Pichat of La Rochelle. Specimens of the pupa, and of the fly hatched from them (Curtoneura stabulans Fall.), were exhibited to the society. The woman had been troubled for some days with bronchitis and very fetid breath, and finally, after a severe attack of coughing, vomited twice. Dr. Pichat afterward found in the basin used a hundred to a hundred and fifty of these larvae; and the circumstances as related by him leave no serious doubt of their source, though he was not present during the vomiting, but only called immediately after it.

This larva, according to Laboulbène, is well known, and is ordinarily found in decomposing animal and vegetable matter, in mushrooms, etc., and has also been reared from caterpillars and hymenopterous larvae.

The possibility of the existence of such flies (Muscariae) in the human body was formerly generally accepted, but has lately been denied by Davaine. Experiments have proved, says Dr. Laboulbène, that such larvae, introduced into the stomach of animals by a fistula, have been discharged alive in the excrement, one, two, or even three days later.

— At the meeting of the Engineers' club of Philadelphia, Nov. 3, Mr. Charles H. Haswell presented 'Notes upon roads, streets, and pavements;' Mr. E. A. Geiseler read an illustrated paper upon 'Tides, and Newton's theory of them;' Mr. Allen J. Fuller spoke of the 'Effect of frost upon fire-plug casings,' — a paper which will be noticed next week under the 'summary.' Professor Haupt also exhibited a 'History of the manual arts, or the inventions of human wit,' published by Mr. Herringman, London, 1661. The secretary read the following account from the *Mexican national* of Laredo, Tex., of a bridge construction by Mr. C. A. Merriam: "On the sixth day of September (the anniversary of loss of bridge last year) the Mexican national railroad-bridge was carried away by high water. On Monday the 16th the first pile was driven for the new structure, which was completed on the 23d; and trains are now running regularly. This is pretty quick work, — the erection of a bridge six hundred feet long in seven days."

The secretary narrated his experience on behalf of the club, and read extracts from correspondence, etc., with the custom-house, through the stupendous inscrutability of the management of which the Transactions of the society of engineers of London, and of the Institution of civil engineers of Ireland, are charged with duty; and all the other foreign societies upon the exchange list of the club are admitted free.

— *Scandinavia*, published in Chicago, is the title of a journal devoted to the interests of Scandinavian life, past and present. It is printed in English, and is intended to keep the American public informed as to the movements, both in politics and literature, among the people of Denmark, Sweden, and Norway. The first number is dated November, 1883.

— Lindström has published in the *Bihang* to the Swedish academy's *Handlingar* an annotated index to the generic names applied to the corals of the paleozoic formations. A list, by Dalla Torre, of the generic names given to Hymenoptera during the decade 1869–79, appeared in Katter's *Entomologische nachrichten* of last December.

— The *Humoristické listy* of Prag for Oct. 27 contains an excellent large portrait of the late Mr. Barrande. We shall publish one next week.

— The mathematical magazine conducted under the name of the *Analyst* for the past ten years, by Mr. J. E. Hendricks, will be continued under the editorial charge of Ormond Stone, professor of astronomy, and William M. Thornton, professor of engineering, with the title, *Annals of mathematics, pure and applied.* The numbers will be issued at intervals of two months, beginning Feb. 1, 1884. In scope the journal will embrace the development of new and important theories of mathematics, pure and applied; the solution of useful and interesting problems; the history and bibliography of various branches of mathematics; and critical examinations and reviews of important treatises and text-books on mathematical subjects. The office of publication will be at the University of Virginia.

— Dr. Macgowan recently sent a communication to the *North China herald* on the art of making luminous paint in the celestial empire. The Chinese, says Dr. Macgowan, used powdered mussel-shells instead of oyster-shells. The method seems to be ancient. The emperor, Tai Tsung, who flourished towards the end of the tenth century of the Christian era, received a picture which was luminous by night. The picture represented, by night, a cow lying within a fence; while, by day, the cow appeared as browsing outside of the enclosure. His Majesty asked for an explanation from his ministers, but they were no better informed than he. At length some one informed the emperor that the effect was produced by mixing Southern-Sea pearl-paste with a pigment which at night became luminous, and that the day-picture was made of a powdered reef-stone. In after-ages the picture was attributed to the genii, whilst some denied its existence altogether. Dr. Macgowan shows, by extracts from a Chinese writer of three centuries ago, that the tradition of the art had not died out.

— The meeting of the Philosophical society of Washington, held Nov. 10, was devoted to the consideration of geologic subjects. Mr. Edwin Smith exhibited a seismographic record obtained in Japan, and described the system of observations conducted by Professor Paul. Capt. C. E. Dutton read a paper entitled 'The volcanic problem stated,' and Mr. W. J. McGee made a communication on the 'Drainage system, and the distribution of loess, in eastern Iowa.'

— John T. Short, professor of history at the Ohio State university at Columbus, died Dec. 11, after a long illness. He was especially well known for his researches in the history of Central America. His 'North-Americans, and their early history,' passed through many editions.

— The papers read at the meeting of the Biological society of Washington, Nov. 16, were by Professor Lester F. Ward, Mesozoic dicotyledons; Mr. C. D. Walcott, Fresh-water shells from the lower carboniferous, with exhibition of specimens; Mr. Frederick W. True, Exhibition of a unique specimen of a West-Indian seal, Monachus tropicalis Gray; Dr. C. A. White, Persistence of the domestic instinct in the cat.

— An unpretending but useful little paper has been lately published as Bulletin no. 5 of the Illinois state laboratory of natural history, by N. S. Davis, jun., and Frank L. Rice. This paper contains concise descriptions of seventy-four species and sub-species of North-American batrachians, and fifty-four of reptiles, found east of the Mississippi. Analytical keys to the families and genera are given, but no synonymy. The classification and nomenclature are those of Professor Cope's Check-list, and the descriptions are in great part compiled from writings of the same author. There is, however, evidence of considerable study of specimens; and the collector of reptiles in the region covered will find this catalogue very convenient.

— A boy fourteen years of age was fishing at Tomioka, Nizen, Japan, recently, when his right arm was seized by a large octopus with two of its tentacles. His cries brought succor as he was being dragged into the water, and the tentacles were cut. The lad reached home; but his arm seemed paralyzed, and in five days death ensued, probably from shock.

— H. Schällibaum recommends a mixture of one volume of collodion with three to four volumes of oil of cloves, to secure microscopic sections in place upon the slide. The oil is evaporated over a water-bath, after which the sections may be stained, etc. An advantage is thus offered over Giesbrecht's shellac method. The full directions are given in the *Archiv für mikroskopische anatomie* (xxii. 689).

— Four mummies have been obtained from the Aleutian region for the Berlin museum. They are in a good state of preservation, and are believed to be of great age.

— M. A. Dumont has submitted to the Paris academy of sciences a suggestion for increasing the irrigating waters derived from the Rhone by regulating the discharge from the Lake of Geneva. This project, recommended by the Geneva commission, involves the expenditure of about £180,000, and the creation of a hydraulic force of 7,000-horse power, by which the level of the lake at high water might be reduced by at least 0.60 m., and the minimum discharge of the Rhone at the outlet increased by 80 mc. per second.

— The science of forestry has hitherto been much neglected in England: but the *Athenaeum* states that the proposal to hold an International forestry exhibition in Edinburgh during the summer and autumn of next year has been taken up with much earnestness; and the sum of £3,500 has already been obtained as a guaranty fund, without any direct appeal to the public at large. Besides specimens of forest produce, implements used in forestry, fungi, rustic work, etc., there will be a collection of illustrations of trees, scenery, forest labor, and the like, along with books, maps, and reports bearing on forest history, surveys, and the geographical distribution of trees.

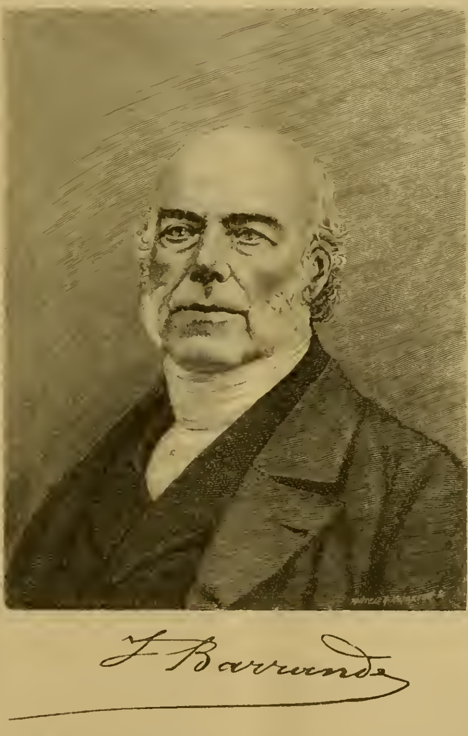
SCIENCE.

FRIDAY, NOVEMBER 30, 1883.

JOACHIM BARRANDE.

I., HIS LIFE.[1]

The death of Joachim Barrande, who for more than half a century has attracted the respectful regards of the world of science, severs the last link between the times of Cuvier and our own. The example of this noble life may be truly said to have borne threefold fruit. He was, after Cuvier, intellectually by far the most dangerous of the opponents of evolution. He was great in his works, and great in the example of a life devoted to research and to the service of his unfortunate sovereign. He belonged to that illustrious body of men who acknowledged Cuvier as their teacher of science; and, in order to understand him, one must recognize this, and also realize that to him loyalty was inseparable from faith and truth. The chivalrous side of his character is best illustrated by the reason which he gave for refusing peremptorily the high honor of an election to the French academy. He said simply that he had no desire for membership in a society with such avowed aims, but which had refused admission to some of his masters in science. — Alcide D'Orbigny, Deshayes, and Edouard Lartet, who had taught him all that he knew. He dedicated himself to science always without personal reservation; but his opinions were never free. He was bound by his loyalty to the memory of his masters in science, and by his faith in the doctrine of the divine right of kings; and both in science and in politics he remained throughout life a consistent opponent of the new theories of evolution and republicanism.



Born in the year 1799, in the town of Saugues, department of Haute Loire, we first hear of him in 1819, when he entered the École polytechnique of Paris, whence he graduated in 1821 among the first in his class, and then passed into the École des ponts et chaussées, graduating in 1824 with high honors.

[1] We are indebted to Professor Jules Marcou, an intimate friend of M. Barrande, for the personal facts in this notice.

During these five years he was assiduous in his attendance on the various courses of lectures given by Cuvier, Brongniart, De Jussieu, Constant Prévost, and Desfontaines, upon zoölogy, geology, and botany, and constantly visited the collections of the Jardin des plantes. After graduation he was appointed engineer at a small town in the basin of the Loire: and there, during one of the visits of Duc D'Angoulême, then the dauphin of France, he was presented to the duke; and any one who has ever had the privilege of Barrande's acquaintance will readily understand the favorable impression his character and attainments made upon his royal highness. Subsequently the young engineer became the most favored candidate of the dauphin for the office of instructor in science to his nephew, the Comte de Chambord, the grandson of Charles X.; and he secured this post for him. The unsolicited appointment to what was considered and sought by learned men as one of the highest honors in the gift of the king, reads like the climax of a fairy-tale; and like that, also, the daring of the young engineer in accepting the appointment had the happiest results for himself and for his royal charge.

The revolution of 1830 put an end to the reign of Charles X., and drove the elder branch of the Bourbon family and their faithful servitor into exile; and it was during the sojourn in England and in Scotland that Barrande perfected himself in the use of the English language. In 1832 they removed to Prague, and carried with them this man who was to make Bohemia classic ground for the geologists of all countries. Barrande found himself here in a new field, where all his previous education and preparation were at fault; but for a true investigator, such as he was, this merely excited the greater interest. He and his pupil began by collecting every thing in the vicinity; and then, little by little, their attention was irresistibly drawn to the fascinatingly rich deposits of Silurian fossils.

Their collections in time became too extensive to be accommodated in the halls devoted to study at the Chateau de Hradschin, and Barrande removed his collections to a house which he had purchased as a residence for himself. With immense labor, and without assistance from books, he built up the first steps of a classification by which he could arrange his collections in natural sequence and in their respective faunas. In 1840 he met with a copy of the 'Silurian system' of Murchison, and became assured of the fact that he was working among similar fossils and in the same geological period. This service was later gratefully and intentionally recognized in the general title of his works, 'Système silurien du centre de la Bohême.'

The royal family changed their residence, going first to Goritz, and then to Frohsdorf; but Barrande, though continuing to serve the Comte de Chambord, having exchanged the post of tutor for that of trusted friend and superintendent of finances, did not live in his household, being permitted to remain with his beloved collections at Prague. His duties, however, called him a part of the year to Paris; and he there leased apartments, first in the rue Mézières, and subsequently in the rue de l'Odéon. There are probably few geologists of reputation who have not, in passing through Paris, made these apartments a visit, and experienced the delight of being received by this stately and warm-hearted gentleman.

Besides the mastery of English, Barrande found it necessary to acquire German, which he spoke and wrote with facility, and also the Czech language, in order to direct and control the workmen employed by him as collectors of fossils. These men varied in number at different times, from six to twenty, and sometimes even to thirty. The practical difficulties which were overcome in this part of the work, and the anecdotes which might be related of the efforts made to deceive him about the localities of fossils, for which he had offered special rewards, would be instructive as well as amusing. We have, however, space only to relate that he acquired among his workmen the reputation of being a generous gentleman, but one of great firmness; and, being obliged also to account for powers beyond their comprehension, they attributed to him a mastery of the black art of divination, and a possible intimacy with the devil himself.

In finishing his work, neither money nor labor was spared: the best illustrators were constantly employed; and one, M. Humbert, became noted, lived constantly with him, and died in his employ after twenty-five years of service.

Barrande found it necessary to be his own publisher. He accordingly organized a French press at Prague; and the typography of his books justify his own assertion, that they could not have been printed with greater technical elegance by any press in Paris. We know from personal inspection that errors are very rare. The quotations, which generally show carelessness, if any part of a book does, excel in this respect; and the desire for correctness has been carried so far, that, instead of tables of 'corrigenda,' he has carefully corrected errors with printed slips pasted upon the pages of the text. All this was done while engaged in administering a fortune of about fifty millions of francs, and arranging many complicated questions of business connected with his position, and relations to the Comte de Chambord, which required much time, and many journeys to different parts of Europe. That this was accomplished successfully is shown by the terms of the will of this last heir of the elder Bourbons, who appointed him his executor. The expenses of the whole work were met by the personal sacrifice of his own income from all sources, but principally by the generous assistance of his royal friend. These presents were always made with the greatest delicacy by the count as his subscriptions to the 'Système silurien de la Bohême:' and Barrande has recognized their essential importance in dedicating each of his volumes to this generous patron, and also by a direct statement that his own labors would have failed but for this assistance. The world of science owes to the Bourbon family its perpetual recognition of this example of friendship and generosity, which has brought out to full fruition the life of one of its representative men.

No government can point to a finer single monument to science than this one, created by an exile in a foreign country; and the sums expended were large, since, as we are assured, the average cost of each of the twenty-two volumes, as estimated by Barrande himself, was not less than twenty thousand francs, making a grand total of nearly ninety thousand dollars for the parts published up to the present time. M. Barrande never married; and his only surviving relatives are a sister, Mme. Vuillet, and a brother somewhat younger, M. Joseph Barrande, a distinguished engineer.

It is impossible adequately to present a life so varied and so full of activity in every direction, at once scientific, and yet so picturesque from political and social stand-points. He had become, before his death, the only survivor of the ancient servitors of the royal house of France; and the cause, and even the surroundings, of his death, completed the beautiful picture of his life of voluntary exile and chivalrous service. He sacrificed himself to his duty as executor, and died from a cold contracted from exposure while engaged in carrying out the last wishes of the man who had been to him pupil, friend, patron, and rightful sovereign. His decease took place Oct. 5, at the Chateau of Frohsdorf, near Vienna, under the same roof, and within a short time after the death of the Comte de Chambord. We who are republicans cannot estimate his motives, nor feel with him as a royalist, but we can respect the rare moral qualities of his devotion; and we feel, also, that it is essential to express our reverence and gratitude to the memory of a really great man for his consideration and kindness to all young students in science who have had occasion to come into personal or professional relations with him.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — IV.

The beginning of the upsetting in a tropical cyclone is not fully accounted for by observation. It is not so easily explained as the first

[1] Continued from No. 42.

uprising on the desert, inasmuch as the ocean's calm surface is too smooth to offer any distinct starting-point for the up-draught. There are, however, several plausible ways out of the difficulty. It is possible that localized warmth and expansion where the air is calmest may produce a gentle up-current, which, once begun, will be soon well established. Again: an excess of evaporation will cause a rapid upward diffusion of vapor. It will reach an altitude where it must condense, and form a cloud-layer, and thereby warm the surrounding air both by its latent heat and by catching the warmth of the sun's rays; and, as this will go on at a considerable altitude, it will be especially effective. Finally, if after a time of calm a breeze should opportunely penetrate the district from an adjoining one of higher pressure, an ascending current would surely be started. In some such way a gradual overturning of the unbalanced air must begin, and its further action is now to be traced.

The rising mass expands as it escapes from the pressure of the air that it leaves below, and in expanding it is mechanically cooled. As it cools, some of the vapor with which it is well charged condenses into cloud, and, on accumulating, soon begins to fall as rain. Here we have the entrance of a new and potent cause of disturbance, — the bringing-forth of a great amount of energy in the form of heat from the condensation of the vapor. It is probable that this aid to the up-draught seldom takes the initiative: it waits till some other cause begins the upsetting, and then falls to with a will to help it along.

This effect of condensation is so important that it may well be considered a little more closely. As water evaporates, its molecules are spread widely apart, and take on a very active motion; but in doing so they must be furnished with energy in some form, for they cannot develop out of nothing the energy needed for their increased activity. As a general rule, the desired supply is found in the sun's radiant heat: so, when water evaporates from the sea-surface, it takes to itself nearly all the energy that comes down in the sun's rays, and thereby its molecules are enlivened up to the point of vaporization. It will be readily understood, that, if heat-energy be taken by the water and transformed into vapor-energy, it can no longer make itself felt as heat; and, so far as our senses are concerned, it is lost or hidden, and for this reason is called 'latent heat.' The term is misleading and improper, for it implies that the sun's energy still remains somewhere in the vapor as a kind of heat that we cannot feel; but this is wrong, for as heat it no longer exists. It will be further seen, that, when the vapor is condensed back again into water, all its vapor energy must take some other form: it must abandon the vapor molecules, and allow them to quiet down and approach one another as they resume the liquid condition; and the energy thus thrown out of employment must make itself felt in some other way. We are therefore prepared to find that condensation is attended with the production of just as much heat-energy as was lost in the process of evaporation. This is of capital importance in the understanding of storms.

It has already been seen, that the cause of continued action in a desert-whirl is found in the excessive warmth of the lower strata; in virtue of which the air in the ascending column finds itself warmer, and hence lighter, than the surrounding air, and consequently is impelled to rise as oil rises through water. It was further noted, that the ascending whirl will continue as long as it is supplied with excessively warm air at the base; but, as soon as the bottom air is not more than 1.6° warmer than the air three hundred feet above it, the whirl will die away. In the case of an ascending column of air saturated with vapor, it would also, as in the previous case, expand as it rose to higher levels of less pressure, and, in consequence of this expansion, it would cool. But when saturated air is cooled, some of its vapor must condense; and when vapor condenses, heat is evolved; and the heat thus produced will partly make up for the loss of heat by expansion, and therefore the ascending column of moist air will not be allowed to cool so fast as if it had not been saturated with vapor. Several important consequences now follow. In the first place, a less warming at the base is needed to produce unstable equilibrium in saturated than in dry air. In the latter, the turning-point is reached when there is a difference of 1.6° F. between the temperatures of the surface-air and that three hundred feet above. In the former, if the surface-temperature be 80°, as is common in the Bay of Bengal, a difference of only 0.6° is required. In other words, if a mass of dry air at 80° rise three hundred feet, its temperature falls to 78.4°: if a mass of saturated air at the same temperature (fig. 5) rise through the same distance, it is cooled only to 79.4°; and conse-

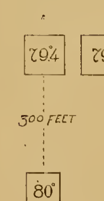


Fig. 5.

quently, for every three hundred feet of ascent it has an advantage over dry air of one degree of warmth (and more at great altitudes), tending to make it lighter than its surroundings, and so intensifying its upward motion. Moreover, a storm which is thus nourished may continue its activity through the night, instead of dying away as the sun declines; for it is supplied with energy continually brought out of the vapor storehouse. Of course, in both cases the sun's heat is the source of the disturbance; but on the desert there is no way of storing up the heat, while at sea a great amount of energy may be stored up before the final upsetting begins, and then the storm-winds arise, and show all this accumulated strength in their blowing.

We have much this kind of action, in a small way, in the formation of a heavy cumulus-cloud on a quiet, hot summer day. The air on the ground is warmed, and contains a good share of moisture; and, as it rises and cools, its vapor begins to be condensed. Some of the vapor-energy is given out as heat, and so the ascending current is re-enforced. If the air be very warm or very moist, or both, the ordinary cumulus-cloud may grow into a thunder-shower; and, being then unable to carry up all its condensed vapor, some of it falls as rain. It should be noted, that, when the lower air is not fully saturated, its temperature must be somewhat reduced to bring it to the point of saturation before any cloud is formed. This decrease is mechanically effected at the rate of 1.6° every three hundred feet, by the expansion of the rising air, — essentially the same rate as that already given for the cooling of a rising column of dry air; and, when enough cooling has been thus effected to reduce the air to its temperature of saturation, some of the vapor will be condensed into liquid cloud-particles, and so become visible. It is for this reason that cumulus-clouds have nearly level bases, and that a group of such clouds stands at about the same altitude. The air-currents rising from the warm ground have to ascend a certain distance, and cool a certain number of degrees, before condensation takes place. Their altitude in feet will be about a hundred and eighty-three times the number of degrees between the temperature of the lower air and its dew-point.

All tropical cyclones are attended by clouds and by excessively heavy rain; and this points very clearly to the important part played by the heat evolved in the condensation of so much vapor. The rapid reproduction of the heat stored up through many previous days of sunshine retards the cooling of the ascending current, excites the winds to active motion, and the storm is thus set going. Espy (1835) was the first to recognize the important part played by the condensing vapor in an ascending current of air, but he greatly exaggerated its effects. The proper measure of its action, and convenient statement of the results in tabular form, are chiefly due to Reye (1864) and Hann (1874).

The ascending current moves outward at a

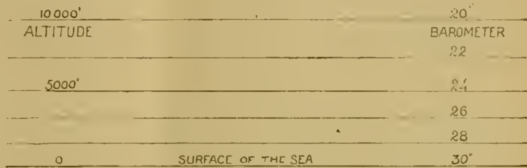


FIG. 6.

height of one or two miles, spreading itself over the surrounding atmosphere. To show its relation to the storm circulation, we may refer to the following figures. Fig. 6 shows the air in a quiescent state, before the storm begins. At such a time, there being no wind, the weight of the air, or the barometric pressure at sea-level, — say, 30 inches, — is uniform throughout the area preparing for cyclonic disturbance. The pressure is uniform, not only at the sea-surface, but also at any given altitude above it (the effect of the upper winds is here omitted as being non-essential to the explanation, as well as unknown); so that the lines in the figure will represent level surfaces of equal pressure of 28, 26, 24 inches, or isobaric planes at altitudes of about 1,600, 3,300, and 5,000 feet. As long as the vertical gravitative pressure is at right angles to these planes, the air is not tempted to move, but will remain at rest till disturbed by some new condition. This new condition will be some form of the disturbing actions already suggested, by which a central region of greatest warmth is determined, in consequence of which there will be an expansion of the atmosphere at that place. The isobaric planes will become convex there, as in fig. 7; for the altitudes at which barometric pressures of 28, 26, 24 inches are found must now be greater than before. As there has been, as yet, no lateral motion, this produces no change in the pressure at sea-level. But a reason for lateral motion has now appeared: the gravitative pressure of the upper air is no longer at right angles to the convex isobaric surfaces, and consequently there will be a tendency for the air to slide down from the centre. In obedience to this impulse, some of the central expanded air moves laterally or radially outward to the marginal region; and now there

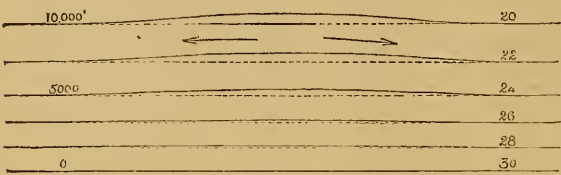


Fig. 7.

is no longer a uniform pressure of 30 inches at sea-level. At the centre, whence the upper air has rolled away, the pressure will be reduced, let us say, to 29 inches: on the surrounding district, over which the air has advanced, the pressure has increased to 30.25 inches. In this new arrangement of pressures there is cause for still further gravitative motion; namely, a rising of the air at the centre, a sinking at the marginal region, and a horizontal motion along the sea-surface, toward the centre of low pressure, in the attempt to restore an equilibrium. But this will not fully overcome the inequality of pressures, or correct the sloping of the isobars; for the existence of an ascending and expanding warm current at the centre requires that the isobaric surfaces there shall be separated by a greater vertical distance than in the normal cooler air of fig. 6. Further, the marginal descending current of air, greatly cooled by radiation in the upper regions, is heavier, volume for volume, than the ascending current, and hence has its isobaric surfaces closer together than usual. A shorter vertical column of it is needed to balance an inch of mercury in the barometer. Fig. 8 shows this final condition, — the diminished pressure and greater separation of the isobaric lines at the warm centre; the increased pressure and the approach of the isobaric lines in the cooler margin. Now, in virtue of the greater distance between the isobars at the centre, the altitude of some surface, say that of 24 inches, will be as great there as over the marginal region, in spite of the inequalities of pressure and inward slope of the isobars at sea-level; and at greater altitudes the isobaric surfaces will become convex, and hence slope outwards, instead of inwards, as below. The two directions of slope will be separated by a level or neutral plane, on which there will be no tendency to motion. Here we have excellent illustration of the convectional motion of the wind in a storm. It ascends at the centre, where it is lightest; it then flows outward, down the barometric gradient; it sinks at the marginal region of higher pressure, and then flows inward, down the reversed gradient, back to the centre again. This may be called the vertical circulation of the storm: and it will be continued as long as the central current is warmed to excess, so as to raise its isobaric surfaces. In the desert-whirlwind we have seen that the supply of warm air depends immediately upon contact with the surface-sands heated by direct sunshine. In the cyclone at sea, the greatest part of the warmth needed is given out by the vapor that condenses at the centre, and falls in the heavy rains, without which a cyclone cannot form. Such a storm may last many days.

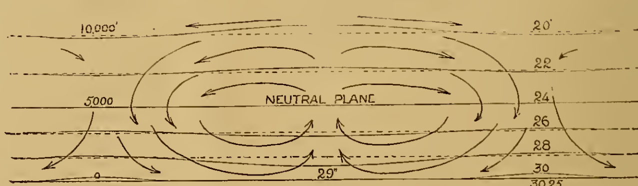


Fig. 8.

The explanations thus far given of the beginning of a cyclone apply strictly only to the hurricanes of tropical latitudes; for in the temperate zones our numerous storms are by no means always dependent on local warmth and calmness of the air. The most that can now be safely said of the origin of such storms is, that they depend on some immediately preceding disturbance, somewhat as one water-wave depends on another; for no one has yet been able to trace one of our storms so far back as to show it quite independent of previous storms, as seems to be the case with the tropical cyclones. In the irregular blowing of the winds of higher latitudes, for which no full explanation can be given, too much air is accumulated in certain districts, which then appear as regions of high pressure. In seeking a better balanced re-arrangement, surface-currents are established with a rotary deflection, as explained below, toward intermediate areas of lower pressure; and an up-draught is formed at their meeting. This becomes a storm-centre. It might be said that friction would soon cause all these local disturbances to cease, and atmospheric pressure would then remain more uniform. So it might, if the air were dry; but the condensation of vapor, by which the cooling of the ascending current is retarded, brings out a new supply of energy every time an up-current is established; and thus the disturbed condition of the atmosphere is maintained. It cannot settle down into a condition of equilibrium as long as the sun shines, and water evaporates. Some maintain that it is unlikely that the storms of the torrid and temperate zones should have different causes, and that as temperate storms certainly do not, as a rule, arise in a warm calm, tropical storms cannot have such an origin. But as already stated, and as will be further shown, the regions and seasons of tropical cyclones point very conclusively to this origin; and, moreover, it is not necessary that similar results should have identical causes. All the peculiarities of a rotary storm can be satisfactorily explained from either starting-point. And the essential contrast between the two cases is, that in one, differences of temperature precede and bring about differences of pressure, and, in the other, differences of pressure precede and bring about differences of temperature; so that, in both cases, the established storm differs in temperature and pressure from the surrounding atmosphere: and, once established, the motions of rotation and translation, yet to be described, are closely alike in the two cases.

(To be continued.)

THE ELECTRIC LIGHT ON THE U. S. FISH-COMMISSION STEAMER ALBATROSS.[1] — III.

To determine the efficiency of the system of incandescent lamps, I measured, by means of a steam-engine indicator, the power required to run the engine and dynamo, the current being switched off. By the same instrument I measured the indicated power required to run 45, 50, and 70 lamps, respectively. By deducting from these experiments, respectively, the power required to run the engine and dynamo, we obtained the power applied to the shaft; and from this quantity we deducted the friction of the load, leaving, as a remainder, the net powers required to revolve the armature in the magnetic field with 45, 50, and 70 lamps in circuit. The lamps used were each of eight-candle power.

Efficiency of the incandescent lamps.

Horse-power required to run the engine and dynamo	5.36
Indicated horse-power required to run 45 incandescent lamps	5.79
Indicated horse-power required to run 50 incandescent lamps	5.85
Indicated horse-power required to run 70 incandescent lamps	6.92
Net horse-power applied to the revolution of the armature in the magnetic field, using 45 incandescent lamps	1.80
Net horse-power applied to the revolution of the armature in the magnetic field, using 50 incandescent lamps	1.85
Net horse-power applied to the revolution of the armature in the magnetic field, using 70 incandescent lamps	2.84
Mean number of incandescent lamps per indicated H.P., using 45 lamps	7.77
Mean number of incandescent lamps per indicated H.P., using 50 lamps	8.50
Mean number of incandescent lamps per indicated H.P., using 70 lamps	10.11
Mean number of incandescent lamps per net H.P., using 45 lamps	25.
Mean number of incandescent lamps per net H.P., using 50 lamps	27.02
Mean number of incandescent lamps per net H.P., using 70 lamps	24.63

The wires being fixed, their resistance may be considered a constant quantity, and the only variation as existing in the engine and dynamo. The distribution of the power, as above recorded, may, if necessary, be verified by electrical measurements on the wires.

To illuminate the machinery on deck, the derrick-gaff, the lead of the cable, the trawl as it comes on deck, and to afford ample light to the naturalists while culling the contents of the trawl as delivered on deck, an arc-light of great power became indispensable. In the then existing state of electric lighting, an additional dynamo appeared to be imperative, as no arc-light had been run from a tension of 51 volts.

The Edison company, however, was willing to experiment, and in a short time produced a

[1] Concluded from No. 42.

lamp of 750-candle power, which we are now using; and we find, in practice, that a no. 18 copper wire will carry the current without heating. The power of this lamp, to be comparable with other arc-lamps, should be multiplied by four, as the commercial candle-power of the arc-lamp is the aggregate of four measurements, the photometers being placed equidistant from each other in the same circumference. The power required to drive these arc-lamps, though more than necessary for others of equal power, is yet quite small.

Efficiency of the arc-lamps.

Indicated horse-power developed by the engine with two arc-lamps in circuit	6.69
Horse-power required to drive the engine and dynamo	3.56
Net horse-power applied to the shaft	3.13
Horse-power absorbed in the friction of the load	0.23
Net horse-power applied to the revolution of the armature in the magnetic field	2.90
Net horse-power applied to the armature for one lamp (half of the last quantity)	1.45

The number of eight-candle power incandescent lamps per indicated horse-power is taken as a mean between the quantities as determined above, i.e., —

$$\left(\frac{25 + 27.02 + 24.63}{3} = \right) 25.55;$$

and this quantity multiplied into the net horse-power required to drive one arc-lamp gives $(25.55 \times 1.45 =)$ 37.04, which is the power in units, of incandescent lamps, to run one arc-lamp of 750-candle power.

Fishermen in nearly all parts of the world use a light in their boats, when fishing at night, to attract fishes into their nets; and it is a common thing for flying-fish to come on board ship at night if a light be advantageously placed to attract them.

Until incandescent lamps were invented, there were no convenient means of sustaining a light beneath the surface of the waters; and there is consequently opened up to us an unexplored field in fishing.

Just what service our submarine lamps will be, we are as yet unable to say: but, with the small lamp which we use from one to ten feet below the surface, amphipods in great numbers, silver-sides, young bluefish, young lobster, squid, and flying-fish, have been induced into the nets, and dolphins have approached it; but whether the dolphins were attracted by the light, or were pursuing the squid, Professor Benedict, the naturalist of the ship, was unable to say. Squid are especially susceptible to the influence of light. I am informed by the very eminent authority of Professor Verrill, of Yale college, that a heavy sea, breaking upon a lee shore when the full moon is casting its rays across the land into the sea, will throw hundreds of squid upon the beach in a single night, — an evidence of their moving in the direction of the light until caught in the spray and hurled upon the shore.

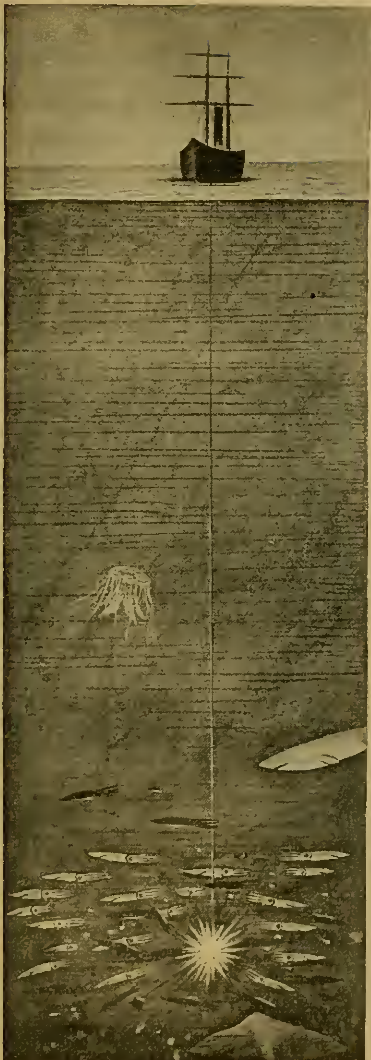
To succeed in producing the light at considerable depths has been by no means easy.

The Edison company first prepared a lantern of two thicknesses of glass, hemispherical in form, with its flat side tightly joined to a bronze disk on which were placed three sixteen-candle-power B lamps in multiple arc. At a moderate depth it burned beautifully; but at about a hundred and fifty feet the packing leaked, and the sea-water, entering, short-circuited, and the lamp was extinguished by the destruction of the cut-out plug. A similar lamp was then tried with improved packing; but its glass walls were crushed by the pressure of the water, and it was extinguished.

The next essay was with a single Edison lamp, its glass vessel being cylindrical in form, with hemispherical end, to give it strength; its thin platinum wires extending through one end without any external attachment. To these delicate wires I succeeded in soldering the copper wires of the cable, but broke (or cut) off one of the platinum wires at the point where it enters the glass, while putting on the insulation. When it is remembered that a hundred fathoms depth of water brings a pressure of over two hundred and fifty pounds per square inch on the lamp, it will be understood that great care was required in every procedure.

Our next attempt was with a single Edison lamp exactly the same as the last. I succeeded in soldering and insulating the joints perfectly; but the pressure of the water upon the insulation cut the delicate platinum wire on the glass before it had reached a hundred feet in depth.

The Edison company then produced a lamp in which the platinum wires were soldered to copper wires in a glass cavity, and filled in with rosin, so that copper wires, about no. 30 in size, projected from the lamp for our attachment. I coiled the copper wires spirally, and soldered their ends to the ends of the heavy wires of the cable, separating them by a small block of pine wood: this gave some freedom of motion, without danger of cutting or breaking the wires. A paper mould was placed round the joint, and filled with warm 'gulloot.' When



FISH-COMMISSION STEAMER ALBATROSS.
A SUBMERGED ELECTRIC LIGHT TO ATTRACT FISH, AND ILLUMINATE THE WATER.

this had cooled, it was wrapped with insulation-tape, and served tightly with twine. This was again covered with gulloot, then tape, and finally with melted gutta-percha; and, when the gutta-percha had cooled, its entire surface was seared over with a hot iron to make sure of filling any cracks or holes it might contain. The lamp was then lowered into the sea, about seven hundred and fifty feet of cable being paid out, without any indication of failure. To ascertain if the lamp was lighted at all times, we substituted a lamp for the cut-out plug in the deep-sea circuit. This brought both lamps in the same circuit, which caused them to glow at about a cherry-red instead of a white light; and had any accident happened to break the lamp in the water, or to cause a leak, our upper lamp would have immediately sprung into incandescent whiteness.

G. W. Baird,
Passed assistant engineer, U.S.N.

CRYSTALS IN THE BARK OF TREES.

In examining the interior of certain insects and myriapods living in and feeding on the wood and liber of decaying trees, the writer has often had his attention attracted by many beautiful and well-defined crystals mingled with the food-contents of the intestinal canal. The crystals appear to be insoluble in the intestinal juices, as they pass through the entire tract unchanged. Recently, in examining a large lamellicorn larva obtained from beneath the bark of a decaying white oak, I again observed an abundance of the same kind of crystals; and shortly after, numerous others were found in a Polydesmus taken from beneath the bark of a hickory log. Feeling sufficient interest in the matter to learn the source of the crystals, I examined a large white oak, dead and decaying, but still standing, with the bark loosely attached. On the inner side of the bark was a thick, yellowish-white, pulverulent layer, — the decayed liber. This readily crumbled to powder; and a small portion, diffused in water and submitted to the microscope, exhibited a multitude of crystals, forming the greater proportion of the powder, and of the kind previously noticed in insects. The crystals appeared perfectly fresh, and not changed by the surrounding decay, but were isolated, sharply defined, and highly lustrous. They measured from about the two-thousandth to the six-hundredth of an inch. Two forms were common, — simple, as represented in fig. 1; and twinned, as in fig. 2. A portion of the powder was submitted to my friend, Prof. F. A. Genth, for analysis, without informing him as to its source. The report was, "It seems to be mostly calcium oxalate, with some carbonate and organic matter." The crystals pertain to the monoclinic system, like the mineral whewellite. In another decayed white oak examined, the pulverulent liber, of darker appearance than in the former, consisted of crystals, cellular *débris*, with no bast-fibres, but with numerous long, dark-brown, many-celled sporidia of a fungus, and a few dead rotifers. Under similar circumstances, the same kind of crystals, equally abundant, were observed in a dead chestnut-tree.

The liber of the fresh or undecayed white oak and chestnut exhibits the calcium-oxalate crystals arranged in close longitudinal rows, as represented in fig. 3, situated among the bast-fibres, and nearly as abundant. The crystals are smaller, approaching the ends of the series; and the spaces occupied by the latter taper at the extremities. Each crystal occupies a separate cuboidal cell, or at least a distinct compartment of a long fusiform space, bounded by the bast-cells. In the rows of crystals of the white oak, from twenty-five to thirty-five were counted, occupying a space of about the fiftieth of an inch in length. In the chestnut liber, from twenty-five to forty-five crystals were counted in different rows. In the liber of the butternut the crystals are compounded in spheroidal clusters, and form rows arranged in the same manner as in the preceding trees.

1

2

3

FIG. 1. — Calcium-oxalate crystal.
FIG. 2. — Twin form of the same. Both from decayed liber of the white oak, magnified 250 diameters.
FIG. 3. — Portion of a series of crystals from fresh liber, magnified 300 diameters.

Without having had any intention of investigating the occurrence of crystals in plants, I have been led to make the present communication on what, to botanists, may be a familiar fact, under the impression that many, like myself, have heretofore been ignorant of it; and this for the reason that sufficient notice of the matter has not been given. Our ordinary manuals, while referring to the occurrence of crystals in plants, and giving a few illustrations of those observed in herbaceous plants, take almost no notice of the beautiful forms in the inner bark of our forest-trees. The 'Micrographic dictionary' mentions the occurrence of raphides in the bark and pith of many woody plants, as the lime and vine, but makes no reference to, nor gives illustrations of, such as occur in oaks, the chestnut, the hickory, etc. No more beautiful example of plant-crystals can be so readily obtained than that exhibited in thin slips of the liber of the oak or chestnut.

Although the occurrence of crystals in vegetable tissues was observed and described by Payen in 1841 (*Comptes rendus de l'académie des sciences*), the first and fullest account of the crystals of the liber of forest and fruit trees was given by Prof. J. W. Bailey, in a communication to the American association of geologists and naturalists, in 1843, afterwards published, with a plate, in the *American journal of science* for 1845, p. 17. Sanio subsequently described the same crystals in the *Monatsberichte* of the Prussian academy of sciences for 1857.

JOSEPH LEIDY.

THE PHYSIOLOGICAL STATION OF PARIS.[1] — II.

THE black screen shown in fig. 4 is a kind of shed, three metres in depth, fifteen long, and four high. This height is necessary in photographing birds on the wing; for, on rising, they immediately leave the dark field. When the walk of a man or an animal is being studied, the opening of the screen is limited by a frame covered with black cloth suspended from its upper part: this regulates the ingress of light under the shed, and makes its cavity darker. In addition, a long strip of velvet two metres and a half broad fills all the lower part of this cavity. Thus the light coming through the bottom of the screen is almost entirely cut off.

In fig. 4 a man dressed entirely in white is walking before the dark screen. The course on which he walks is slightly inclined, in such a way that a visual ray, proceeding from the objective, passes very near the surface of the ground without meeting it anywhere. This is necessary in order that in the picture the feet of the walker may be entirely visible, while the ground is not: otherwise the light reflected from the ground would make an impression on the sensitive plate at the very points where the images of the feet should be produced, and make them obscure. The course is raised about twenty centimetres above the surrounding ground; and along the full length of this relief there runs a plank on which alternate divisions, each a metre and a half long, are painted black and white. The plank thus divided is seen in the photographs, and is useful in measuring the distance run between two successive images, and in estimating the size of the subject, the amplitude of his reactions, and the extent of displacement of each part of his body. In order to know the rapidity of movement, the time consumed in traversing the various spaces must be measured. Now, if the machinery which

[1] Concluded from No. 42.

Fig. 4.

turns the disk always worked with the same speed, and if the number of openings were the same for all experiments, we should only have to determine once for all the interval of time which elapses between two images, and we should immediately have the expression of the rapidity: in short, if the successive illuminations were separated by one-tenth of a second, and if the interval in long measure between the images were five-tenths of a metre, it is evident that in one second five metres would be traversed. But the rapidity of the disk varies with the experiment: it must, then, be controlled. This control can be obtained by means of a chronograph which shall indicate the interval of time between the various turns of the disk during the experiment. But this method would give two kinds of independent indications, — that of the spaces on the photographic plate, and that of the times on a revolving cylinder. It seemed to us better to obtain, also on the plate, the indications of the times elapsing between the successive images. This result was obtained in the following manner. In order to know the frequency of rotation of the disk, we have only to photograph the successive positions of a body moving with a uniform and known velocity. Fig. 4 shows, above the head of the walker, an apparatus which answers this purpose, and which we will call a *photographic chronograph.* It is a black velvet dial, on which bright nails, arranged in a circle, divide the circumference into a certain number of equal parts. A bright needle on the face of this dial is in continual motion, turning at the rate of a revolution a second. It is evident, that, if the disk of the photographic apparatus revolve only once a second, we shall have only one image of the needle on the dial; if the disk make six revolutions a second, we shall have six images, etc. Since the velocity of the disk is uniform, the images on the dial are separated by equal distances. These divisions allow us to easily estimate the fraction of a second corresponding to the interval between the images.

This method will be better comprehended if we consider its application. Fig. 5 represents a runner jumping a bar. The series of photographs commences at the moment when the leaper started on the preliminary spurt, and ends when the leap is finished, and the fall to the ground has partly destroyed the velocity. Let us analyze this figure. We see the subject represented nine times; that is, the disk revolved nine times during the experiment. Each rotation, bringing the opening of the disk in front of the objective, has permitted light to enter for a brief instant, which has sufficed each time to give an image. These successive images were produced at different points on the plate, because the leaper himself occupied different positions before the screen when each of the illuminations took place. The space traversed either on the ground or in the air, between successive images, is easily measured by means of the divisions in the planks

Fig. 5.

seen at the bottom of the picture. We see that the interval is not always the same, and that, if we suppose equal intervals of time to separate successive images, the greatest velocity occurs in the run which preceded the leap, and that there was a diminution of speed while the leaper was in

Fig. 6.

the air: in fact, this diminution is still increased after the fall, the velocity being partly lost the very moment the body touches the ground. In order to know whether the images have been produced at equal intervals of time, and the duration of these intervals, the dial of the chronograph must be consulted. It is then seen that the luminous needle is represented as many times as there have been illuminations, namely, nine times; that the interval between the illuminations was uniform, for the images of the needle whose rotation was uniform form equal angles: in short, the absolute value of the time-intervals between the illuminations is expressed by the angle which the images of the needle on the dial make. This angle is about 36°, which shows that the time-interval between successive illuminations is one-tenth of a second. From these measures of time and space we easily deduce the velocity of the leaper in the various phases of the experiment. This speed was seven metres a second during the preliminary run, five metres during the leap, and fell to three metres and a half after the fall.

When one takes on the same plate a series of photographs representing the successive attitudes of an animal, he naturally tries to multiply these images in order to know the largest number possible of the phases of movement; but when the latter is not rapid, the frequency of the images is soon limited by their superposition, and by the confusion which results. Thus, a man running even at moderate speed can be photographed nine or ten times a second (fig. 6) without confusion of the images. If sometimes one limb is depicted where the other limb has already left an impression, this superposition does not at all affect the images: the white only becomes more intense where the plate has received two impressions, so that the contours of the two members are still easily distinguishable. But when a man walks slowly, as in fig. 7, the images present so many superpositions that confusion results. This inconvenience is remedied by *partial photography*; that is, by suppressing certain parts of the image in order that the rest may be more easily distinguished. As by our method white and bright objects only make an impression on the sensitive plate, it is necessary merely to clothe in black the parts of the body which we wish to exclude from the image. If a man dressed half in white and half in black is walking on the track, and turns toward the photographic apparatus the part clothed in white, the right, for instance, there will appear in the picture only the right half of his body. These images allow us to observe in their successive phases, first, the pivot-like turning of the lower limb around the foot during the time of support; and second, as the foot rises, the turning of the same limb around the hip-joint, while at the same time this joint is moving forward without cessation.

Partial photographs are also serviceable in an analysis of rapid movements, because by this means the number of attitudes represented may be many times

Fig. 7.

increased. Nevertheless, when the image of a limb is moderately large, the partial photographs cannot be too much increased without confusion through superposition. We must therefore diminish the size of the image, if we desire to repeat them at very short intervals. For this purpose the walker is clothed wholly in black, and narrow bands of some bright metal are placed down his arm, thigh, and leg, following precisely the direction of the bones of these parts. This arrangement allows us to easily increase tenfold the number of images received in a given time on the same plate: hence, instead of ten photographs a second, we can obtain one hundred. For this, the rapidity of rotation of the disk is not altered; but, instead of one opening, there are ten, equally distributed on the circumference. One of these openings must have a diameter twice that of the others. The result is a much larger size for one of the images; and this renders the estimation of the time easy, and also furnishes data to compare the movements of the lower and upper limbs. The images obtained under these circumstances are so close, that one is present, as it were, at all the successive changes of place of the limbs and body. Thus, in fig. 8, between two successive touches of the ground by the right foot, there are twenty-one different positions of the lower limb. As the foot meets the ground, the knee is bent perceptibly; then it straightens as the foot, resting on the toes, prepares to leave the ground. After the raising of the foot, the knee bends again, and the leg forms with the thigh a right angle; then it gradually becomes straight, and the sole of the foot, which was at

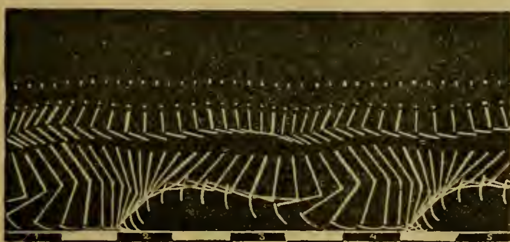


FIG. 8.

first in a vertical plane, is apparently parallel to the ground which it touches for some time before it rises again. The scale at the bottom of the figure shows that the total length of the step was 2.6 metres. The chronograph was not used in this experiment, but we may estimate the number of images at about sixty a second. The movements of bending and extending the fore-arm are obtained in the same manner as those of the leg. The turnings of the head are expressed by the undulatory motion of a bright point placed on a level with the ear. In short, the diminutions and the accelerations of each part are expressed by the crowding or separation of the images. To ascertain the corresponding positions of the arm and leg at a given instant, we take for data every fifth figure, which is larger than the others. These images are formed at the moment of passage before one of the larger openings; and they correspond, therefore, to the same instant of time. This is not the place to analyze in detail the various types of locomotion. The few examples just given sufficiently explain the method, and show its exactness. For a complete study of human locomotion, photographs under the most diverse circumstances must be obtained. The subject must be photographed not only from the side, but also from the front and rear, in order to show the lateral oscillations of the different parts of the body. Finally, after studying the mechanism of the various motions produced in walking or running, the final result — the more or less rapid transportation of the man — must be studied, either as he walks freely, or as he bears or draws a burden.

These researches have a practical interest, even as those having for their object the determination of the product of machines, and the most favorable conditions for this production. Experiments in regard to this are in process; and it is with this object in view that the circular course with telegraphic signals, to note the phases of the walking or running, has been established.

THE FUNDAMENTAL CATALOGUE OF THE BERLINER JAHRBUCH.

A VERY important comparison by Dr. Auwers, of the fundamental catalogue of the *Berliner jahrbuch* with those of the *Nautical almanac*, the *Connaissance des temps*, and the *American ephemeris*, appears as a supplement to the *Jahrbuch* for 1884; and the following abstract of it is given. The year 1883 is the first in which such a comparison is possible.

The *Berliner jahrbuch* contains at present, and will contain for the future, 450 stars whose apparent places are given, and 172 stars for which only mean places are printed; i.e., 622 in all. The places of these stars, both in R. A. and Dec., depend strictly on the system of the Fundamental catalogue of the *Astronomische gesellschaft* (publ. xiv.). They lie between the north pole and — 31°.3 declination.

The *American ephemeris* contains the mean places of 383 stars, for 208 of which ephemerides are given: 44 of these stars lie south of —31°. The *Nautical almanac* has 197 stars (15 south of —32°), and ephemerides are given for all. The *Connaissance des temps* has 310 stars between the north pole and — 70°, and gives an ephemeris for each.

Dr. Auwers's account of the sources from which the star-places of the various almanacs are taken we omit. It shows how various these are. 450 stars have ephemerides in the *Jahrbuch*; 149 stars (mostly southern) which have ephemerides in the three other almanacs are not contained in the *Jahrbuch*.

A table is given in Dr. Auwers's paper, showing the comparison between each star of each almanac and the *Jahrbuch*. From this table the elements by which the catalogue of each almanac can be reduced to the system of the *Jahrbuch* are deduced. A subsequent table gives the two reductions which must be added to each almanac R. A., and the two reductions which must be added to each almanac Dec., in order to reduce to the system of the *Jahrbuch*.

The catalogue of each almanac, after the application of the systematic reductions from this table, is then compared with the Fundamental catalogue. For the *Nautical almanac*, the mean difference in declination is 0″.395; in R. A. (from 134 stars), 0s.0332. Of the 168 stars common to both almanacs, there are 27 whose R. A. differs more than 0s.067, and 8 whose declinations differ by more than 1″. These differences are, in the main, errors of the *Nautical almanac*, and are largely due to the erroneous proper motions adopted in the Greenwich catalogues.

For the *Connaissance des temps*, the table shows large systematic errors. After these have been eliminated, the comparison shows for 229 stars, common to the *Connaissance des temps* and the *Berliner jahrbuch*, a mean difference of 0″.373 in declination, and a mean difference of 0s.0282 (from 162 stars) in R. A. The errors here, again, are largely due to erroneous proper motions.

The correspondence of the reduced positions of the *American ephemeris* with those of the *Jahrbuch* varies according as one or another basis of comparison is chosen. A complete comparison can only be made for those stars for which ephemerides are given, since the newer stars have their positions derived from several sources, not comparable among themselves.

The declinations of the *American ephemeris* and those of the *Jahrbuch* agree excellently for those stars which have been investigated by Boss. The mean difference (162 stars) is 0″.177. The other 111 stars do not agree so well, there being 12 differences between 0″.5 and 1″. The stars north of 64° depend upon Gould's R. A.; and, of the 36 stars common to both almanacs, 15 differ by more than 0s.15. Of the remaining 126 stars whose ephemerides are given, 8 have differences as great as 0s.067. The mean difference for 100 stars between +40° and −20° is 0s.0127. For the 111 stars without ephemerides, there are seven cases where the difference is more than 0s.067.

For the stars south of −32°, the *Nautical almanac* will give the best positions, on account of its data being derived from the most recent catalogues.

A comparison of the system of the *Jahrbuch*, 1861–82, with the new system, and a general table for the reduction of the data of any almanac to the *Berliner jahrbuch* system, concludes this very important paper.

It is to be hoped that in the immediate future all star positions may be reduced to the system of the *Jahrbuch*, and its admirable list of stars will be amply sufficient for observers in the northern hemisphere. For the determination of time and longitude, the stars of the other almanacs will serve a useful purpose, especially as they may easily be made homogeneous with the Berlin list by tables given by Dr. Auwers in this paper.

EDWARD S. HOLDEN.

Washburn observatory, University of Wisconsin,
Madison, July 24, 1883.

LETTERS TO THE EDITOR.

English *ch*.

IN SCIENCE, ii. 452, you assert that the English '*ch* (in *chair*) is not a simple consonant, but a compound,' consisting of '*t* followed by *sh*, as is apparent in pronouncing with 'due lingering emphasis' the words, 'even *such* a man, so woe-begone,' etc. Now, the same length and emphasis may be produced by a prolongation or continuous repetition of the vowel-sound of the word 'such,' and, it seems to me, would be so in the case of anybody who was unacquainted with the *tsh* theory. But even if not, the change from a simple *ch* to a compound *tsh* would not be the only instance in the language, where under special circumstances, such as a prolongation or drawl, a sound is liable to an essential change; and it must be peculiarly so where the sound can be properly made only by an instantaneous movement. *Ch* seems to be caused by such a movement, just as a smack of the lips is, which is certainly a decidedly different sound from the one made in the same way, except more gently and slowly, — a *p* made with inward-drawn breath. The relation between the smack and that *p* seems to be the same as the relation between the English *ch* and *t*, and the difference in each case to depend on the mode of contact and of its interruption, not on any combination or succession of sounds.

Again: it appears quite possible to pronounce the word 'chair' perfectly with the teeth kept slightly open by the finger or a pencil, and held, therefore, in such a position that it is impossible to pronounce the word 'share' correctly, showing that *sh* is not properly a part of the *ch*.

Moreover, if *ch* is the same as *tsh*, or the German *tsch*, the Germans would at the outset have no difficulty in pronouncing the English *ch* in a way not noticeably different by its hissing sound from ours.

It has been said, that after pronouncing the word 'check' to a phonograph, on turning the machine backwards, the sounds re-appear as *kesht;* but is that not wholly due to an incorrect, prejudiced pronunciation of the first word, as if written *tshek?* L. B.

Nov. 9, 1883.

[Argument is out of place in reference to what is a matter of mere observation. The suggested experiment by 'lingering emphasis' ought to satisfy any ear as to the reality of the stopped or shut commencement of the sound of *ch* in *chair*, and of its hissing termination. L. B. evidently associates some meaning different from the ordinary one with the terms 'simple' and 'compound.' *Ch* is compound because its shut commencement and its hissing termination are elementary effects, each of which is susceptible of separate utterance. — EDITOR.]

Report of the Assos meeting.

Henry W. Haynes, Esq., calls my attention to an error in the remarks on Assos made by me at the meeting of the Archaeological institute, Oct. 31, and printed by you in your recent report (SCIENCE, no. 41).

For 'to fight against Ramses III. — the Rhampsinitos of Greek story,' read, 'to fight against Ramses II. — the Sesostris of Greek story.'

May I beg you to make this correction public.

JOSEPH THACHER CLARKE.

Boston, Nov. 19, 1883.

Analysis of the wild potato.

In the spring we received from Mr. J. G. Lemmon, Oakland, Cal., some tubers said to be of Solanum tuberosum, var. boreale, and collected in Arizona. Of thirteen tubers planted May 4, nine furnished plants, which bloomed July 12, and in September ripened a crop of tubers no larger than the seed planted, or of the size of small hazel-nuts. The leaves were small, deep grayish-green above, not hairy; the stems, much branched, deep purple at the nodes; the flowers, white and numerous. The tubers were very diffusely spread in the soil.

An analysis of the tubers harvested by the station chemist, Dr. S. M. Babcock, is as below: —

Water	64.44
Ash	1.17
Albuminoid (N. × 6.25)	4.86
Crude fibre	.78
Nitrogen (free extract)	28.62
Fat (ether extract)	.13
	100.00

E. Lewis Sturtevant, *Director*.

N. Y. agricultural experiment-station, Geneva, N.Y., Nov. 14, 1883.

Musical sand.

In September (no. 31) you published a brief abstract of our preliminary paper on the singing-beach of Manchester, Mass. Since then we have continued our investigations, and collected additional data and material. One of us has just returned from a visit to the singing-beach on the west shore of Lake Champlain, four miles and a half south of Plattsburg, Clinton county, N.Y. This beach is about seven hundred feet long, crescent-shaped, and terminates at the south end in low cliffs of limestone, and at the north end in shelving rocks of the same material. About a hundred feet north of the beach the limestone is quarried for building-purposes.

The acoustic phenomena previously described in connection with Manchester and Eigg are reproduced at Lake Champlain quite perfectly. On the occasion of our visit, however, the sand retained traces of moisture, and the noise, indicated by the syllable *groosh*, was less strong than it would otherwise have been. Two tests, however, showed that the sound made by rubbing the sand with the hand, and pressing it on the strata below, could be heard distinctly at a distance of more than a hundred feet. The tingling sensation in the toes, produced by striking the sand with the feet, was also perceived. We failed, however, to obtain sounds by rubbing the sand between the palms of the hands, — a method which yielded remarkable results at Manchester and at Eigg; but this failure is doubtless due to the imperfect dryness of the sand. Having learned, by experience with samples from the aforesaid localities, that they lose their acoustic properties after repeated friction, we tested this question directly on the beach. We found, that, by rubbing a definite quantity of sand continuously, its power of emitting sounds gradually diminished, and finally ceased.

The sand is unusually fine, and its grains of remarkably uniform size, averaging about 0.2 millimetre in diameter. Even to the naked eye their tendency to a spherical shape is apparent; and, when examined under the microscope, they are found to consist, to the amount of about thirty per cent, of round and polished grains of colorless quartz, usually of spherical, ellipsoidal, and reniform shapes; about the same quantity of angular to subangular grains of the same mineral, colorless, reddish, and yellowish, sometimes enclosing scales of hematite, grains of magnetite, and fluid cavities; a considerable number of fragments of a triclinic felspar, angular to subangular, colorless, and sometimes exhibiting cleavage-planes, and lines of striation; many short fibres and fragments of hornblende, and apparently augite, of a deep green color, often irregularly colored reddish brown by decomposition, and possessing strong dichroism; and a few minute particles of menaccanite and magnetite.

In conclusion, we will be greatly obliged to any reader of Science for information of additional localities of sonorous sand, and especially for samples for microscopical study.

H. C. Bolton and A. A. Julien.

Nov. 19, 1883.

November shower of meteors.

Watch was kept here for the November shower of meteors by myself and a number of students on the mornings of the 13th and 14th, — on the 13th from 2 to 4, on the 14th from 2 to 6. The observers were in a room having southern and eastern exposures, and meteoroids were looked for only in those directions. It was quite cloudy on the 13th, and only one meteoroid was seen; nearly clear on the 14th; and considering the fact that the moon was nearly full, and stars of the fourth magnitude could not be seen without attention, more meteoroids were seen than were expected, nearly all coming from the radiant in Leo. Owing to the fact that their appearance was not frequent enough to maintain constant attention, it is likely that most of those which were near the limits of visibility escaped observation. The maximum seemed to be at about 4.30. At 3.20 a very brilliant one, much exceeding Sirius in brilliancy, was seen.

Michigan agricultural college. L. G. Carpenter.

SOME RECENT STUDIES ON IDEAS OF MOTION.

Studien über die bewegungs vorstellungen. Von Dr. S. Stricker, professor in Wien. Wien, *Braumüller*, 1882. 6+72 p. 8°.

These studies are efforts in experimental psychology, with accompanying speculations, by a physiologist who has already written upon like subjects in his 'Studien über das bewusstsein.' The style is fragmentary, and not always very clear; and there are some confusing efforts to frame a new terminology. Above all, the author's training in general philosophy is very imperfect; and therefore what he says in the latter half of this essay, 'Ueber die quellen unserer vorstellungen von der causalität.' is almost wholly antiquated and insignificant, having been superseded ever since Hume, whom, in fact, our author seems in one respect to have wholly misapprehended. But in his direct observations of mental facts, Professor Stricker attracts one's attention as having given some independent contribution to the discussions about the relation of the muscular sense to our ideas of motion. Even here, it must be remarked, he pays little attention to the fact that others have been at work before him, and seems to think his ideas quite new. Yet what he has done is to observe, and record his observations; and in so far forth he has done what we want done in the psychological field.

Professor Stricker asserts that practice in the use of his muscles, and especially in the training of the muscular sense for mechanical purposes, has rendered him uncommonly well qualified to note the presence of muscular sensations as elements in any complex state of mind. Some of his colleagues have like skill. He has thus been led to pay attention to facts such as, that, when he perceives the movements of another person, or remembers these movements clearly afterwards, or deliberately imagines a movement of a man or even of an animal, he always is aware of a slight feeling of effort in those muscles of his own body that would be concerned in the same or in some analogous movement. The appreciation or conception of a bodily movement is thus accompanied by a more or less well-marked dramatic imitation of the movement. Again: if he perceives or conceives the visible motion of a body in space, he is conscious of a motion, or of a tendency to motion, in the muscles of the eye. These personal observations he finds confirmed by others in proportion to their training in introspection, and in the special observation of the muscular sensations. In watching the motions of many small objects at once in the field of vision, as in case of a snow-storm, the author is not quite so fortunate. "I find difficulty," he says, "in discovering any trace of motions of the eyes; yet, after long exercise, I have now no longer the least doubt that I follow the single flakes with small and quick motions or nascent motions of the eyes" (p. 23). In case, however, of an effort to picture in memory just how a snow-storm looks, the author either finds himself picturing a stationary mass of flakes, or else following in mind the motions of single flakes. In the latter case he discovers that the muscles of the eyes are perceptibly innervated. The result, therefore, notwithstanding the difficulty, is in the end the same.

In the case of the illusions of motion in the 'wheel of life,' the author asserts that the illusion is always accompanied by motions of the eyes, and that it is impossible without such motions.

His conclusion from all this is, that "motion is conceivable only in connection with, and by means of, the muscular sense," — a result that, in this extreme form, probably very few investigators will accept. Certainly Professor Stricker has not proved it; since he has, on the one hand, left very numerous facts wholly unnoticed, and, on the other hand, has adduced facts that are of doubtful force for his purpose. As for the omitted facts, a reviewer of this book in the *Philosophische monatshefte* has challenged Professor Stricker to show what part the muscular sense plays in the perception of the motion of an object seen double in indirect vision, when the eyes are fixed on some chosen point. Thus, if one's gaze is fixed directly in front on some bright point, or on one of the eyes of the observer's own face as seen in a mirror, so that the eyes are surely at rest, then the finger, or a pencil, held up so as to appear double, will yet in both its shadowy images be seen to move when the real finger is moved, or when the pencil is moved by an assistant without the observer's previous knowledge. Yet here, says the reviewer, the double images show that the eye does not follow the motion at all, else they would coalesce. And if the mirror is used, the observer, looking at his own eye in the mirror, can be doubly sure that his eyes are motionless. This objection, however, is not so near at hand as another, mentioned by the same reviewer, — the one that must at once occur to any reader of Professor Stricker's book; viz., the case of the motion of some small object over the skin, say a crawling insect. Here the motion is felt as motion, and not as mere tickling, as soon as the requisite speed and amplitude are attained. What has the muscular sense to do here?

But, obvious as these objections are, they are not final. Professor Stricker might reply, that, according to Lotze's own suggestion, the now well-recognized *localzeichen* themselves may be of the nature of muscular impulses. In the retinal field the tendency to bring any point of attention into the point of sight may exist universally; and the motion of the indirectly seen finger over the resting retinal field may be known by reason of the change in the magnitude and direction of the effort that during the experiment constantly exists, to bring the finger, as the object most attended to, into the point of sight. Something analogous may make possible the perception of the motion of a point on the skin. But these are hypotheses. They are doubtful; and they require of Professor Stricker supplementary investigations, whereof he seems to have had no thought.

There remain, however, the cases of what a late writer in the *Wiener sitzungsberichte* (Fleischl, *Optisch-physiol. notizen*, no. vi., in bd. lxxxvi., i., for 1882) has called *bewegungsnachbilder*, which have long been observed and discussed. These are the subjective appearances of motion in the visual field, after the continued observation of swiftly-moving real objects; as when one has been looking at a waterfall or at a rotating-disk. Helmholtz, indeed, explains all these appearances together as visual vertigo; putting them with the phenomena of apparent motion in dizziness, and regarding them as all alike caused by motions of the eyes, unconsciously continuing after the cessation of the observation of the objective motions. Yet Helmholtz has trouble to apply this explanation, whose validity in its own class of cases is undoubted, to the case where contrary motions appear in the field of vision at the same time; and Hering, in Hermann's 'Handbuch der physiologie' (iii., i., 562), insists for these cases on the rival explanation, "Die scheinbewegung beruht auf einer localen reaction des sehorganes gegen die vorangegangene erregung." Thus we should have true spectra of motion.

One may add, that the recent article by Drs. H. P. Bowditch and G. Stanley Hall in the *Journal of physiology*, vol. iii., p. 297 sqq., leaves no room to doubt that optical illusions of motion of this class do exist, that cannot be explained as resulting from visual vertigo, and that can properly be called *bewegungsnachbilder*, at least until we know more about them.

If, now, the explanation of Helmholtz is not sufficient for all cases, if there are any cases of true *bewegungsnachbilder*, then surely they cannot be brought in any wise under Professor Stricker's extreme theory without a simply appalling mass of hypotheses. Such cases are insisted upon by Fleischl in the note above cited; and he even notes the curiously contradictory character of the spectra of motion, — the presence in them of a motion, without any actual transferrence from place to place that the eye *can* follow. They excite him to the rather petulant outburst with which his note closes; viz., that *empfindungen* are fundamentally illogical, and that the principle of contradiction does not hold good for them, but only for their more developed relatives, the *vorstellungen*. Perhaps, however, our author will insist that it was of *vorstellungen* only that his studies treat, and that with such wicked and illogical *empfindungen* as Fleischl's *bewegungsnachbilder* he has nothing to do. Yet, if his theory is to be complete, he must not be allowed to shrink from its applications. What can he do with the own cousins of these illogical phenomena, namely, the chaotic sensations of the darkened visual field? Here is for some eyes, such as the present reviewer's, little more than motion or change, without any power of distinguishing what it is that moves. So it is with Mr. Galton ('Human faculty,' p. 159). Helmholtz himself describes, in his own case, motions of 'two systems of circular waves advancing towards their centres;' and so, of course, there must be for him, in the darkened field, motions at the same time in contrary directions, that cannot well be explained as the result of muscular efforts. A similar experience is described by Professor LeConte (in his book on 'Sight,' p. 72); and Purkinje's observations, as Helmholtz gives them, are also to this effect. In all these cases, then, we have motions — whether manifold and confused, or definite and regular — which, it would surely seem, cannot be explained as resulting from, or in any way implying, muscular sensations. These cases, then, lie wholly out of Professor Stricker's range.

Yet possibly it may not seem to most readers worth while to spend time in refuting the hasty generalization of our author. But the object here is to suggest both the necessary limitation and the possible scope of this theory of the ideas of motion. Its limited scope seems clear, but its very one-sidedness is instructive if we look a little closer. It is one-sided, for instance, in the inductive methods used. In case of the mental picture of the snow-storm, Professor Stricker found his theory in danger of failing: so he followed the single snow-flakes with the mind's eye; and lo! the theory is verified, and so throughout. The influence of attention upon the result is so plain, that the reader must have noticed the fact in reading our previous summary of the book; and yet this formal error in the reasoning does not make the result wholly erroneous. If one takes note in himself of the facts upon which such stress is laid by our author, one will very readily find that there is at least this in them; viz., every clearly conceived or perceived objective motion tends, just in proportion to the *clearness and definiteness* of perception or of conception, to become associated with a certain kind, degree, and direction, of muscular effort. That muscular efforts are involved in mapping out the visual field; that we follow every point in whose motion we take special interest, and are partially conscious of what we do in following it; and that analogous facts exist for the sense of touch, — are truths now generally recognized. Professor Stricker is interesting as having given us an independent, and, in so far forth, unprejudiced, contribution to the theory. That it has charmed him over-much is itself a fact of interest for the theory: for it shows how much clearer and better Professor Stricker seemed to himself to have conceived motions, when he had brought their conception into immediate connection with the facts of the muscular sense; that is, we see hereby how the muscular sense, used as the *measure of the amount of our activity*, is for that reason the especial means of helping us to build up definite ideas of complex facts. Motions we could know, it would seem, apart from the muscular sense; but we should have no such clear ideas as we have of the differences among motions. Even so it probably is with space. We should know of space if we were motionless; but we should not know of what Mr. Shadworth Hodgson calls figured space, — space mapped out as the mathematician needs to map it out. In fact, the connection of the muscular sense with the simple perception of movement, to form the complex perception of the definite character of the manifold differences between one movement and another, gives us an excellent illustration of that general law of mind according to which as many originally separate mental facts as possible are constantly being brought together, in order that, from their blending, a new and more definite unity may come. Increased complexity of data running side by side with increased simplicity of form, — this is the law of mental progress; and so the motions perceived by the pure sense of touch become definitely comparable with one another, and with the motions of the pure sense of sight, by means of the union of both with the data of the muscular sense, the whole thus forming the basis for higher rational mental processes.

Professor Stricker's facts are also useful as independent illustrations of certain other allied laws that have been elsewhere recognized. For instance: the tendency to join the conception of a motion with an imitation or nascent imitation of this motion has been before illustrated by the phenomena of hypnotism, by the gestures of sensitive and vivacious people, by the facts of so-called 'mind-reading,' and by many similar and very common experiences. Professor Stricker has attended more to these imitative tendencies than most people are accustomed to do, and has verified them subjectively for himself. Mr. Galton's 'histrionic associations' ('Human faculty,' p. 198) belong to the same group of facts.

Another law, however, is indirectly verified by Professor Stricker, as far as his observations go; and it may be well to mention this law here, because, so far as the present writer knows, little attention has been devoted to it by psychologists. It is the law formulated as an aesthetic principle in Lessing's 'Laocoön,' that moving objects, actions, events, can be properly described by the poet in language; while things that have to be spoken of as resting, and, in general, things that are coexistent, cannot successfully be represented by language. Still more generally stated as a practical principle of the rhetorician, the law is, that, to describe vividly, one must seize upon every element in the object that can be spoken of in terms of motion or action, and must either neglect or very briefly indicate whatever elements cannot so be interpreted. This principle explains one use of personifications, whether total or partial. The mountains rise into the sky, or lift their heads; the lake stretches out before one's sight; the tower looms up, or hangs over the spectator, — such are some of the more familiar devices of description. An exception that illustrates the rule is found in the case of very bright colors, whose interest and comparative brilliancy in the mental pictures of even very unimaginative persons may make it possible for the descriptive poet to name them as coexistent, without suggesting motion, particularly if he render them otherwise especially interesting. So in the well-known description, in Keats's 'St. Agnes' eve,' of the light from the stained-glass casement, as it falls on the praying Madeline. Even here, however, the light *falls*. And color-images, however brilliant, are increased in vividness by the addition of the suggestion of motion; as in Shelley's 'Ode to the west wind,' where

> "The leaves dead
> Are driven like ghosts from an enchanter fleeing,
> Yellow, and black, and pale, and hectic red,
> Pestilence stricken multitudes."

Much less effective would be the mention of the most brilliant autumn hues apart from motion.

Lessing gave as basis for this theory the somewhat abstract statement that language, being spoken or read successively, is best fitted to portray the successive. But this is hardly the whole story. The modern generalization that men and animals alike observe moving more easily than quiet objects, in case the motion is not too fast or too slow, seems to come nearer to offering an explanation. But this account is still incomplete; for it will be found that we do not always picture mentally the motion of an object, even when we try to do so. To see a man walk in the mind's eye is not always so easy as to picture a man in some attitude. Professor Stricker notes that his dreams seldom picture to him actual motions. In many dreams we must all have noticed that the rapid transitions that take place are rather known as motions or alterations that have happened, than as changes in process of taking place. The present writer's own image with Shelley's lines above quoted is not so much of dead leaves actually moving, as of the leaves rustling, with the sense or *feeling* that they are driven by the wind. The words descriptive of motion give, rather, the feeling of action connected with the leaves, than a picture of movement itself. So, to say that the mountains *rise* is to direct the mental eye upwards, rather than to introduce any picture of objective motion into the mental landscape. So, then, it seems probable, that, while we notice moving rather than resting things, our mental pictures tend to be representations of resting attitudes, rather than pictures of motion. And the greater vividness which descriptions of motion nevertheless possess would seem to be due to the sense of activity that they introduce into our ideas of the objects; and that this sense is connected with the muscular sensations that we are accustomed to associate with all clearly perceived motions seems both probable in itself, and in some wise confirmed by Professor Stricker's observations. The whole leads us, in fact, to another probable law of mental life; viz., that, since an animal's consciousness is especially useful as a means of directing his actions, the ideas of actions, however they are formed, will naturally be among the most prominent elements of the developed and definite consciousness. We need not make any assertion about the direct source of these ideas. Whether the active muscular sense is a direct consciousness of the outgoing current, or a true sense through the mediation of sensory nerves, the result will not affect either Professor Stricker's argument or our own suggestions.

In conclusion it may be well to say, that, if psychology were already a developed experimental science, such independent and hasty observations and generalizations as our author's would hardly be worth discussion. But as things are, even very imperfectly conducted observations, if they are direct and sincere, must be thankfully accepted. Something of the same sort may possibly hold good of the similarly hasty suggestions that have here been thrown together.

JOSIAH ROYCE.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Algebraical equations. — M. Walecki, in a note presented to the Académie des sciences by M. Hermite, gives a proof of a fundamental theorem in the theory of algebraical equations; viz., that every algebraical equation has a root. The theorem being evident for real coefficients, M. Walecki assumes the coefficients as imaginary, and writes the first member of the equation in the form $P + iQ$, and also makes $F(x) = P^2 + Q^2$. He considers first the case of an equation of odd degree, say p; then it is only necessary to prove that the equation $F(x) = 0$, of degree $2p$, has a root. To do this, he writes $x = y + z$, and distinguishes the odd part in z from the even part in the development of $F(y+z)$, writing thus: $F(x) = \varphi(z^2) + z\psi(z^2)$. The resultant of ϕ and ψ is shown to be a real polynomial of odd degree in y, and vanishing for a real value of y. Two cases present themselves: viz., one of the functions φ or ψ may vanish identically; and this can only be ψ, for the coefficient of the term of highest degree in ϕ is not zero. Then, ϕ being of odd order, $F(x)$ has a real divisor of the second degree. The second case is when ψ is not identically zero, and when ϕ and ψ have a common divisor, $F(x)$ being then decomposed into the product of two factors. The author shows, then, that in either case a divisor of $F(x)$ is obtained of either the first or second degree, and with real coefficients; thus proving the proposition for an equation of odd order. A similar investigation is given for equations of even order. — (*Comptes rendus*, March 19.) T. C. [409

A differential equation. — M. l'abbé Aoust has here given a method for obtaining the formula giving the general integral of the differential equation —

$$x^n \frac{d^n y}{d x^n} + A_1 x^{n-1} \frac{d^{n-1} y}{d x^{n-1}} + \ldots + A_n y = F(x),$$

by aid of a certain multiple definite integral. The quantities $A_1, A_2 \ldots A_n$ are constants. He proposes first to solve the problem of finding a function, φ, in terms of another function, ψ; the two functions being connected by the relation —

$$\psi(x) = \int_0^1 d\,a_n \int_0^1 d\,a_{n-1} \ldots \int_0^1 d\,a_1 \varphi\left(a_n^{\frac{1}{a_n}} \ldots a_1^{\frac{1}{a_1}} x\right).$$

The process for the reduction of this is by substituting successively z_1 for $a_1^{\frac{1}{a_1}} x$, z_2 for $a_2^{\frac{1}{a_2}} z$, etc.; and finally the expression of ϕ in terms of ψ is obtained. The transition from the solution of this problem to the solution of the problem of finding the general integral of the given differential equation is then indicated, and the integral given in the form —

$$y = \Sigma_1^n M_i x^{a^i} + \frac{1}{a_1, a_2 \ldots a_n} \int_0^1 d\,a_n \int d\,a_{n-1} \ldots$$
$$\int_0^1 F(a_n a_{n-1} \ldots a_1 x)\, d\,a_1.$$

The quantities $M_1, M_2 \ldots M_n$ are arbitrary constants, and a_1, etc., roots of a certain algebraical equation. — (*Comptes rendus*, March 19.) T. C. [410

ENGINEERING.

Effect of frost upon fire-plug casings. — Mr. Allen J. Fuller referred to a general impression that the freezing of the earth around fire-hydrants has a tendency to gripe fast to the frost-jacket, and lift it with the expanding or heaving earth, which he denied for the following reasons. 1°. The frozen earth slides on the surface of the frost-jacket, because its expansion is greater than that of iron. 2°. As the expansion of the earth must be in proportion to the intensity of the cold, so will it be greater above than below a given point: therefore the first foot of frozen ground will have a greater upward movement than that which is below it, and the second foot greater than the third, etc. Thus it will be seen that the earth below a given point rises more slowly than that above, and its friction is opposed to the one above. 3°. If this is true of feet, it is true of inches and of portions of an inch: therefore there is a retardation movement throughout. 4°. The upward movement of the ground: the freezing being greatest towards the surface, and such movement involving a more complete fracture of the earth surrounding the frost-jacket, it follows that the friction is less at this point than that below it, and in consequence there is less power to move upward than downward. Of course, the above does not apply to any construction that the frost can get beneath.

Mr. Frederic Graff noted and described the form of wooden casing which had been successfully used in the early practice of the Philadelphia water-department.

In response to the theory advanced in regard to the action of frost in raising the casings of fire-plugs, and to the statement that if the base of a structure extended below the frost-line it would not be lifted, Prof. Haupt remarked, that he thought the theory was in part sustained by the fact observed by some of the district surveyors, and verified by the accurate measurements they were obliged to make, that fences moved bodily to the south and east in consequence of the action of the sun and frost upon the ground on opposite sides of them. He thought, also, that the deductions concerning the immobility of structures resting below the frost-line were not fully sustained by the facts; as in the north-west, where ice forms rapidly, he had heard of numerous instances of piles driven for bridges, and extending some distance below the frost-line, having been raised as much as five to six inches in a single night; and he conceived the action in this case to be similar in kind to that of piles driven entirely through solid ground, the only difference being in the *amount* of the resistance offered by friction and weight of pile. The water, in freezing around the pile, acts upon it as a griper or vice; and the expansion of the various strata or laminae of water, as they become converted into ice, acts as a lever to force up the pile.

Mr. Howard Murphy did not consider the case cited by Prof. Haupt as parallel, as the so-called piles, being driven through water and soft mud, were probably columns resting upon their bases, and depending but little upon the frictional resistance of the material through which they passed. Therefore the expansive force upward of the freezing water would be opposed by little more than the weight of the pile; whereas in a fire-hydrant casing, or other deeply planted post, the presumably well-rammed material around the whole length under ground would offer such proportional frictional resistance as to cause the freezing earth to slide up the post rather than to lift it. If the ice could be supposed to act downwards upon the piles in question, it is hardly likely that it would have forced them farther home. — (*Eng. club Philad.; meeting* Nov. 3.) [411

An enormous steam ferryboat. — The Solano, on the Central Pacific railroad ferry, between San Francisco and Oakland, Cal., was built by the Harlan & Hollingsworth company of Wilmington, Del. The boat is 494 feet long on deck, 406 on the water-line, 116 feet beam, 6½ feet draught, loaded. The tonnage is given as 3,540. The engines are two in number, beam-engines working independently, having cylinders 62½ inches in diameter, and of 11 feet stroke of piston. These engines are each rated at 2,000-horse power. The boilers are 8 in number, of steel, have 19,630 square feet of heating-surface, or about 1,500-horse power according to a usual rating (12 square feet to the horse-power). The wheels are 30 feet in diameter, and are fitted with 24 buckets. There are four lines of rails on the deck; and 48 freight or 24 passenger cars can be carried at once. — (*Mechanics*, July 28.) R. H. T. [412

Surface-condensers for marine engines. — Cadet engineer J. M. Whitham, U.S.N., compares the performance of surface-condensers of marine engines with the results of a formula for required area of surface constructed by him, and deduces a constant for usual application. He obtains the expression, —

$$S = \left\{ \frac{L}{T_1 - t} + \log_e \left(\frac{T_1 - t}{T_2 - t} \right) \right\} \frac{W}{c\,k},$$

in which

S = square feet of condensing-surface,
W = pounds of steam condensed per hour,
L = latent heat of steam of temperature, T,
T_1 = temperature of exhaust-steam,
T_2 = temperature of feed,
t = mean temperature of circulating water,
c = coefficient variable with efficiency of surface,
k = conductivity of the metal (556.8 for brass, 642.5 for copper).

He finds the usual value of c to be 0.148. He finds that this figure may be increased ten per cent where independent circulating pumps are used. The common value of $c\,k$ is taken as 82.2252. An inspection of the table of areas in use indicates that the smallest areas are very nearly as efficient, as a rule, as the greatest. — (*Proc. naval inst.*, ix. 303.) R. H. T. [413

Protection of iron from rust. — As it has been observed that iron embedded in lime-mortar is hindered from rusting, Riegelmann of Hanau uses a paint containing caustic alkaline earth (baryta, strontia, etc.), so that the iron may be protected as it is by lime. The *Neueste erfindung* states that a mixture of ten per cent of burnt magnesia, or even baryta or strontia, mixed cold with ordinary linseed-oil paint, and enough mineral oil to envelop the alkaline earth, will protect iron by its permanent alkaline action, the free acid of the paint being neutralized. — (*Build. news*, Sept. 14.) C. E. G. [414

Asphalt mortar. — A composition of coal-tar, clay, asphalt, resin, litharge, and sand, an artificial asphalt, has been used for some years with perfect success on the Berlin-Stettin railway for wall-copings, water-tables, and similar places requiring a waterproof coating. It is applied cold, like ordinary cement. The space to be covered is thoroughly dried and cleaned, and then primed with hot roofing-varnish, the basis of which is also tar. The mortar is then spread cold with the trowel, to a thickness of three-eighths of an inch. If the area is large, another coat of varnish is given, and rough sand strewn on. The material is tenacious, impregnable to rain or frost: a piece exposed four years to the drainage of a slope thirty-three feet high is perfectly sound, and has required no repairs. — (*Centr.-blatt. bauverw.*) C. E. G. [415

AGRICULTURE.

Relative value of soluble and reverted phosphoric acid. — Experiments by Voelcker gave no result, the differences between the unmanured plots being greater than those between manured and unmanured plots. Wildt, in experiments in five different places, found in one case that the soluble form gave the greatest increase, in three cases no effect could be observed from the phosphoric acid in any form, and in one case the results were contradictory. — (*Biedermann's centr.-blatt.*, xii. 514.) H. P. A. [416

Influence of quality of seed upon the crop. — One of the most important conditions of a successful vegetation experiment is uniformity in the seed used. With this in mind, Hellriegel has investigated the effect of variations in the absolute weight, and in the specific gravity of seeds upon the growth of the resulting plants. He finds, that, of seeds (of barley) having the same specific gravity, the heavier seeds produced at first more vigorous plants than the lighter. As the plants continued to grow in good soil, the differences gradually diminished, until, at the time of harvest, they had entirely disappeared. When the plants grew in poor soil, the effect of differences in the seed was more lasting, and even affected the total weight of the crop. Differences of specific gravity in seeds of the same weight produced no recognizable effect upon the crop. The stage of ripeness of the seeds affected the development of the plants in the same direction as it did the absolute weight of the seeds; the riper seeds being heavier, and producing the most vigorous plants, and the differences being most manifest on a poor soil. Essentially the same results were obtained in experiments with potatoes. The attempt was also made to raise potatoes of greater or of less specific gravity, by selection; the heaviest or lightest being continually selected for seed. The experiment was continued through three seasons, with a negative result. — (*Ibid.*, xii. 530.) H. P. A. [417

MINERALOGY.

Albite. — This mineral usually occurs somewhat impure, owing to the presence of small quantities of potassium and calcium. C. Baerwald claims to have found for the first time a perfectly pure albite from Kasbék, Caucasia, in which no trace of potassium or calcium could be detected, and which yielded, on analysis, SiO_2 (68.75). Al_2O_3 (19.73). Na_2O (12.29) = 100.77; gravity, 2.618. This albite is regarded as of special interest in relation to Tschermak's theory, that the soda-lime felspars are all isomorphous mixtures of a pure soda felspar (albite, $Na_2Al_2Si_6O_{16}$) with a pure lime felspar (anorthite, $CaAl_2Si_2O_8$), giving a continuous series between the two extremities which vary in physical properties. Pure albite not being known, an idea of its properties was arrived at by calculation, and the author regards it of interest to compare the albite from Kasbék with the theoretically pure albite of Tschermak.

	FOUND ON ALBITE FROM KASBÉK.	CALCULATED BY TSCHERMAK.
Gravity	2.618	2.624
Angle of base on brachypinnacoid,	86° 22′,	greater than 86° 29′

When examined with crossed nicols and sodium light, the extinction upon a basal section was found to be 2° 17½′ on either side of the twinning-plane; and, with a section parallel to the brachypinnacoid, the extinction took place at an inclination of 18° 23⅜′. These values vary considerably from those arrived at by Schuster, respectively 4° 30′ and 19°; but the author regards his values as especially correct, being obtained by experiment on pure material, and not by calculation. — (*Zeitschr. kryst.*, viii. 48.) S. L. P. [418

GEOGRAPHY.

(Arctic.)

Population of the Chukchi peninsula. — Dr. Aurel Krause gives a *résumé* of the exploration of this district from the middle of the seventeenth century, and a discussion of the ethnic relations of its people, largely from the observations of himself and brother during their late travels. To this is added a small ethnological map, showing the distribution of the various stocks on either side of Bering Strait; and a valuable vocabulary, chiefly of Chukchi words, but containing also some words of the Asiatic Eskimo, and some recognized as jargon. — (*Deutsche geogr. blätter*, vi. 3.) W. H. D. [419

Hydrography of the Siberian Sea. — Otto Pettersson contributes to the second volume of the 'Scientific results of the Vega expedition' a study of this subject, illustrated by charts of the Kara Sea, and of that part of the Arctic Ocean between Novaia Zemlia and Bering Strait which has been named the Nordenskiöld Sea. An important part of the paper consists in the discussion of the movements of the ice in the Kara Sea, which, the author concludes, depend less on wind and weather than on the varying amount of warm surface-water which enters the Kara basin in different years. This warm water depends largely upon the discharge of the great Siberian rivers, and differs according to the time when the ice in them breaks up in different years. As a complement to this investigation, may be mentioned a paper on Nordenskiöld's explorations, printed by Fr. Schmidt of the St. Petersburg academy of sciences, in which the author endeavors to clear up some doubtful points in the observations made on the Vega voyage, by combining with them the results of explorations by Saunikoff, Hedenström Anjou, and others. — W. H. D. [420

New charts of north-east Siberia. — The Hydrographic office of the navy department has issued a chart of Plover Bay, derived from Russian surveys by Maksitovich, and one of the Anadyr River estuary, founded on the surveys of the Telegraph expedition in 1865, with corrections by Russian officers on the ship Haidemak, in 1875. Following an error of the Russian hydrographic office, the title of 'Port Providence' is given to the whole of Plover Bay, and the latter name to the smaller and included port, in direct reversal of the custom of American and other navigators for the last thirty years. — W. H. D. [421

Graah's investigations of 1829–30 in Greenland. — Apropos of Nordenskiöld's Greenland expedition, a very full account of Graah's voyage, and a deserved tribute to his qualities as an explorer, appears in the last number of the *Deutsche geographische blätter*. This is doubly useful, as the account of the journey originally published has long been out of print, and difficult to obtain. The same number contains a statement and criticism of the hypothesis offered by Nordenskiöld in regard to the interior of Greenland, from the pen of Prof. Börgen, whose views have been sufficiently confirmed by the results of the voyage, so far as yet made public. — W. H. D. [422

(*Africa.*)

The Portuguese in Africa. — In support of the rights claimed by Portugal on the Kongo, and elsewhere in the interior of Africa, a memorandum was issued, some time since, by the geographical society of Lisbon, in which it was claimed for Portuguese explorers that they had revealed to science precise and exclusive information in regard to the orography and hydrology of the Dark Continent. The plea of this memorandum has been traversed by President Wauters, of the Royal Belgian geographical society, in a very lively and interesting article. Without expressing an opinion as to the merits of parties now struggling for supremacy on the Kongo, attention may be called to the manner in which the author shows how the characteristics of the hydrology of the interior of Africa on ancient charts were derived. Two centuries before the Christian era, Eratosthenes, from information obtained on the Ethiopian expedition of Ptolemy Philadelphus, described with tolerable accuracy the chief features of the river-system of Abyssinia, and placed the source of the principal branch of the Nile in a lake situated to the southward of that country. Ptolemy and the Arabian geographers added other lakes and branches, the details of which appear to have been based chiefly on rumor and imagination. In 1444 certain Abyssinian monks visited Rome on an ecclesiastical errand; and, from information derived from them, Brother Mauro corrected the geography of that part of the Nile basin comprised in the Abyssinian watershed, the remainder finding its source on a vast marsh located in the centre of the continent. This appeared on his celebrated Mappe-monde in 1458.

According to the author and Father Brücker, the curious network of lakes and rivers found on the globes of Martin Behaim and medieval geographers, which suggest so curiously the lakes and rivers now known to exist, were all derived from the sources above mentioned. In many cases the names of the lakes and towns can be recognized; and in suppressing synonymes, and replacing Abyssinian rivers (which appear spread over central Africa on such maps) where they belong, the central region of the continent becomes almost a blank. It was reserved for the celebrated De Lisle, in the early part of the last century, to sweep from the charts every thing not due to actual observation, leaving to Livingstone and his successors the occupation of the blank thus made by delineating the physical features recognized in these modern and only authenticated explorations. — (*Bull. soc. Belg. géogr.*, ii. 1883.) W. H. D. [423

BOTANY.

Synonymy of higher cryptogams. — The 'Nomenclator der gefässkryptogamen,' by Carl Salomon, gives the genera and species of the higher cryptogams, together with their synonymes, and the geographical distribution of the species, — a work which is much needed by students in this department of botany. — W. G. F. [424

Ohio fungi. — The third part of the 'Mycological flora of the Miami valley,' by A. P. Morgan, has appeared, and includes the species of Agaricini from Coprinus to Lenzites. The paper is accompanied by colored plates of two new species, — Coprinus squamosus and Hygrophorus Laurae. — (*Journ. Cinc. soc. nat. hist.*) W. G. F. [425

Phycologia Mediterranea. — In this volume of about five hundred large octavo pages, Prof. F. Ardissone of Milan describes the Florideae of the Italian coast, followed by the Bangiaceae and Dictyotaceae, under the heading Incertae sedis. From the context, however, one understands that the writer considers the two last-named orders to be nearly related to the Florideae. The descriptions and synonymy are given in full in Latin, and there are many notes in Italian on the microscopic structure and development. The antheridia of Spyridia are said to be unknown. They have, however, been described and figured in American specimens of S. filamentosa, which also occurs in Italy. — W. G. F. [426

Pollination of Asclepias. — Dr. Taylor speaks of the temporary capture of flies by A. purpurascens, and of the removal of pollinia by them on their escape, and suggests that North-American botanists examine the insects caught on our asclepiads for the peculiar pollen-masses (*Sc. gossip*, Sept.).

Like Apocynum, the milkweeds have long been known to catch insects not adapted to fertilize their flowers; and irritable movements have several times been ascribed to their pollinia or stamens (e.g., Kirby and Spence, 'Entomology,' 7th ed., 167; Willdenow, 'Principles of botany,' 321; Potts, *Proc. Philad. acad.*, 1878, 293). In reality the insects are captured by a purely mechanical action of the fine V-cleft in the saddle of the pollen-mass, which seems especially adapted to hold the tarsal hairs of insects, especially certain Hymenoptera.

The pollinia have been frequently noticed on insects. Bee-keepers often complain that their bees become so weighted with them as to be unable to regain the hive. Potts (*Proc. Philad. acad.*, 1879, 207) mentions one bee which bore the remains of thirty pollinia; and Bennett (*Pop. sc. review*, 1873, 343) speaks of a butterfly which had eight entire masses, and the bases of eleven others, on one of its feet. Curious mistakes have also been made in descriptive entomology through a failure to recognize these bodies when they have been met with on insects. Savigny, in his great work on Egyptian insects ('Hymenoptera,' pl. 11), figures one as an appendage of the maxillary palpus of a Larrid; and his figure is copied by Westwood ('Modern classif.,' ii. 197), who says (p. 201) that 'it may possibly be the effect of disease.' Reakirt (*Proc. ent. soc. Philad.*, ii. 357) described them as natural appendages of the tarsi of a butterfly, giving them the name of eupronychia. If I am not mistaken, a species of Mantispa has also been characterized by the presence of these pollen-masses; but I am unable to refer to the description.

Among the numerous modern accounts of the pollination of the genus, none is more thorough than that given by Delpino, in his 'Fecondazione nelle piante antocarpee,' 1867. — W. T. [427

ZOÖLOGY.

Rare forms of microscopic life. — Dr. A. C. Stokes recently described and exhibited specimens of a new species of Acineta, a stalked, loricate infusorium. At the same time he called attention to an example of the blue Stentor (Stentor ceruleus Ehrenberg) which he thought had not been mentioned heretofore as found in America. He also announced that he had recently collected the beautiful rotifer, Stepanoceros Eichhornii, which, though abundant in Europe, appears not to have been previously found in this country. Specimens of Salpingoeca urceolata were also shown, which in no way differed from marine specimens. All the above forms of minute life were found in Watson's Creek, a small fresh-water stream in Mercer county, N.J. — (*Trenton nat. hist. soc.; November meeting*, 1883.) [428

Mollusks.

Pulmonata of central Asia. — E. von Martens publishes a valuable contribution to our knowledge of central Asiatic Mollusca. The region treated of is between the frontiers of China and the Caspian, for which material has been gathered by Prjevalski, Potanin, and Regel. Besides descriptions of new forms, it contains a review of the fauna, with a tabular exhibit of the distribution of the different species. The central Asiatic Helices are broadly divisible into two groups: the one, characterized by reddish and yellowish tints of coloration, and related to the Fruticicola of Europe, is more northern in its distribution; the other, allied to Xerophila, inhabits the Thian-Shan region, and is distinguished in general by sharper sculpture and a whitish color. Several forms common to the pleistocene and to the boreal region are found here, while several sections of the Helices not found in the pleistocene are also absent from central Asia. The fauna is more nearly related to that of the post-tertiary, or northern American, than to the existing fauna of middle Europe. The fresh-water snails are European, but Unio is conspicuous by its absence. A supplement by Schacko gives anatomical details of several species. — (*Mém. acad. St. Pétersbourg*, (7), xxx. no. 11.) W. H. D. [429

Mediterranean oysters. — The Marquis de Gregorio has undertaken a special study of the Mediterranean oysters, recent and fossil. Two short papers printed at Palermo give some preliminary results; among other things determining the existence in a living state, on branches of red coral, of the true Ostrea cochlear of Poli, believed to have become extinct. We recall, however, the identification of this species some time since, by Dr. Jeffreys and others, from specimens attached to a telegraph-cable which had been recovered from great depths for repairs. — W. H. D. [430

Mollusks at the fisheries exhibition. — Dr. J. Gwyn Jeffreys prints some notes on the Mollusca exhibited. Leaving out oysters, which were well represented from Great Britain, the United States, and France, the collections are not remarkable. British Columbia showed a fine example, in spirit, of Cryptochiton Stelleri. This species, by the way, though rare in European collections, is abundant in proper localities from Santa Barbara, Cal., north and west to the extreme limit of the Aleutian Islands. It is eaten raw by the natives of Alaska. Norway showed a small collection of fine specimens of her mollusks, as did the museum of Gothenberg, Sweden. The most important and interesting collection was that of the Vega, dredged in the Arctic seas from Norway to Bering Strait by Baron Nordenskiöld. Among these was a Pleurotoma (from the description, closely resembling P. circinata Dall, of the Aleutian Islands), which Dr. Jeffreys believes to be larger than any other known species, and to which he has applied the name of P. insignis. — (*Ann. mag. nat. hist.*, Aug., 1883.) W. H. D. [431

Worms.

Notes on worms. — C. Vignier has published a preliminary notice of his researches on the annelid Exogone gemmifera in the *Comptes rendus* (xcvi. 729), and promises a full memoir. —— W. H. Caldwell gives, in the proceedings of the Royal society of London (xxxiv. 371), a preliminary note on the structure and development of Phoronis. —— A third preliminary publication is that on the development of Borlasia vivipara, in the *Bulletin scientifique du département du Nord* (v. 462), by W. Salensky. —— In the journal of the Linnaean society of London (xvii. 78), Dr. T. S Cobbold describes Ligula Mansoni, n. sp. Twelve specimens were found, in a Chinese, lying in the subperitoneal fascia about the iliac fossae, and behind the kidneys; a single one being found lying free in the right pleural cavity. They were twelve to fourteen inches long, and an eighth of an inch broad, and come near Ligula simplicissima. —— H. Griesbach has given a preliminary report of his observations on the connective tissue of cestods, as studied in Solenophorus. His article appeared in the *Biol. centralbl.* (iii. 268). —— J. Poirier found in the intestines of Palonia frontalis, from Java, three new Amphistomidae, for which he establishes two new genera, — Homalogaster and Gastrothylax. Three species are described and figured (*Bull. soc. philom. Paris*, (7), vii. 74). —— J. Chatin reports a few observations on the histological alterations occasioned in man by trichinosis (*Ibid.*, 107). —— The larvae of Gordius occur both in fishes and in many insect-larvae. In opposition to Villot, von Linstow maintains that the insects are the real hosts, and the parasites are present in fishes only accidentally, from their feeding on infested insects. — (*Zool. anz.*, vi. 373.) C. S. M. [432

VERTEBRATES.

Direct irritability of the anterior columns of the spinal cord. — Mendelssohn, in the present paper, states that he has repeated all of the experiments of Fick upon the irritability of the anterior columns, and obtained similar results. In his own experiments, special efforts were made to prevent any escape of current on stimulating. The spinal cord was laid bare in its whole extent, and isolated from the surrounding parts by caoutchouc. The anterior and posterior columns of the cord were stimulated just below the brachial plexus, which had been previously divided; and the movements of the gastrocnemius muscle which resulted were registered upon a myograph. In some cases the anterior portion of the cord was completely separated from the posterior by a section running from the origin of the sciatic to the cervical cord. It was found in all cases that the reaction of the anterior columns was shorter than that of the posterior columns; that is, the time between stimulation of the cord and contraction of the gastrocnemius was less in the first case than in the second, the difference in time varying from 0.01 to 0.025 of a second. Assuming that the contraction resulting from stimulation of the posterior columns is reflex, then that resulting from stimulation of the anterior columns must be direct. — (*Arch. anat. physiol.*, 1883, 281.) W. H. H. [433

Fishes.

Sudden increase of a rare sunfish. — Professor A. C. Apgar recently referred to the results of a fishing-excursion in central New Jersey. He found that the hitherto rare species of sunfish (Mesogonistius chaetodon) was remarkably abundant, and in a short time gathered seventy-five specimens. Where heretofore the common spotted sunfish (Enneacanthus simulans) and the still more abundant 'pumpkin-seeds' (Lepomis gibbosus) have been the characteristic species, these now appear to be largely crowded out by the small banded sunfish, which but a short time ago was only to be found in scanty numbers and in very limited localities. — (*Trenton nat. hist. soc.; November meeting*, 1883.) [434

Birds.

Anatomy of Biziura. — From the dissection of two males of B. lobata, Mr. Forbes finds that this duck forms an exception in that its trachea is simple, and devoid of a bulla, and that a subgular pouch, comparable to that of the bustards, exists. The ambiens tendon perforates the patella, as in Phalacrocorax and the Hesperornis of Marsh. — (*Proc. zoöl. soc. Lond.*, 1882, 455.) J. A. J. [435

Does the Carolina wren mimic? — Dr. C. C. Abbott read a short paper on the habits of the Carolina, or mocking-wren (Thryothorus ludovicianus). He had carefully studied a pair of these birds for a year, seeing the male bird at least three times each week, from September to September. In all that time he had never heard the male bird utter a note not distinctively its own. Prof. Austin C. Apgar remarked that he had been familiar with the song of this wren for years, but had not heard it mimic; yet in all works on ornithology that refer to this species it is called the mocking-wren; and the habit is more or less referred to by Wilson, Audubon, and by Baird, Brewer, and Ridgway, in their 'History of North-American birds.' — (*Trenton nat. hist. soc.; meeting* Sept. 19.) [436

The tongues of Tenuirostres. — In this paper, Gadow describes the modifications of the tongue which adapt it for sucking. The basal portion of the tube is formed by the rolling-up of the tongue, while the tip is formed by the rolling-up of the divided portion. In the Melaphagidae the end is broken up dichotomously into several tubes, and only the external borders of the tubes are lacinated. In the Hectariniinae the end is formed of only two tubes, and the internal edge is lacinated. In the hummers the tongue is double to near the base. Some peculiarities of the serpi- and mylo-hyoid muscles are mentioned. We notice that the author gives the anterior cornua of the hyoid apparatus as obsolete, though he describes the os entoglossum as double. From this we infer that he has forgotten that the ossa entoglossa are the anterior cornua. — (*Proc. zoöl. soc.*, 1883, 62.) J. A. J. [437

Mammals.

Innervation of the movements of the iris. — In the reflex narrowing of the pupil, which takes place when the eye is exposed to light, it has been generally accepted that the afferent fibres concerned in the act follow the same general course as that taken by the rest of the fibres of the optic nerve, passing along the optic tracts to a centre somewhere in the neighborhood of the corpora quadrigemina. Bechterew has shown that this is not the case. Section of the optic tracts in various places, from the chiasma to the corpora geniculata, causes no dilatation of the pupil, and does not interfere with the reflex narrowing of the pupil when exposed to light. Injury of the corpora geniculata and of the corpora quadrigemina, so long as the lesion in the latter case does not extend so deep as to involve the origin of the oculo-motor nerves, gives the same result. Lesions of the gray matter of the lateral and posterior walls of the third ventricle, on the other hand, cause a widening of the pupil, and a loss of the 'direct' light reflex in the eye of the same side. If, however, the eye on the uninjured side is exposed to the light, a narrowing of the pupil of both eyes takes place, appearing to show that the lesion has involved only the afferent fibres, and not the reflex centre. The author's view of the path of the fibres is, that they leave the optic nerve at the chiasma, pass directly into the gray matter of the walls of the third ventricle, and end finally each in the nucleus of the oculo-motor nerve of its own side. The fibres do not cross anywhere in their course, since lesions of either side affect only the corresponding eye; and a sagittal section of the floor of the ventricle or of the chiasma is without effect. The nuclei of the oculo-motor nerves he considers as the true centres for the reflex: and the commissural fibres connecting these nuclei explain the occurrence of the indirect reflex, that is, the narrowing of one pupil when the pupil of the other eye is exposed to light. The dilatation of the pupils which follows painful stimulation of any portion of the periphery of the body cannot be owing to stimulation of fibres running in the sympathetic; since, in the first place, the widening is not maximal, as it is when the sympathetic is directly stimulated. and, in the second place, this reflex is entirely destroyed when a deep section is made behind, or in the posterior part of, the corpora quadrigemina. He explains the action of painful stimuli as an inhibition of the normal light reflex contraction of the pupil. The pathological reflex paralysis of the iris, which occurs in certain diseases, in which the iris does not respond to stimulation of the eye by light or to painful stimuli of the body, is owing, he thinks, to an affection of the gray matter of the third ventricle. — (*Pflüger's archiv*, xxxi. 60.) W. H. H. [438

ANTHROPOLOGY.

Languages and ethnology. — In a recent communication, Gustav Oppert proposes to divide languages, according to the mental propensity towards concreteness or abstractness possessed by the various races, and exhibited in their speech, into concrete and abstract languages. The concrete division is again separated into the heterologous (having special words when persons of different sex address each other), and homologous (males and females use the same words as if addressing their own sex). The abstract division is separated into digeneous and trigeneous. In the former all things are either masculine or feminine: in the latter there are three genders. Each division is again subdivided into three classes, as follows: 1°. Elder and younger relatives have special terms, sex denoted by the words 'male' and 'female,' or by modulation; 2°. Having special terms for elder brother and elder sister, but one in common for younger brother and younger sister; 3°. Having four distinct terms for each variety of kinship. Representing the concrete and abstract by C and A, their classes by α and β, and their groups by 1, 2, and 3, and the monosyllabic, incorporative, euphonic, euphonic inflectional, alliteral, agglutinative, agglutinative inflectional, dissyllabic inflectional, inflectional synthetical, and inflectional analytical, by I., II., III., IV., V., VI., VII., VIII., IX., and X., any

Physiologic.		Heterologous α. 1	Heterologous α. 2	Heterologous α. 3	Homologous β. 1	Homologous β. 2	Homologous β. 3	Digeneous α.	Trigeneous β.
I.	Monosyl.	–	–	–	–	–	Chinese?	Old Egyptian.	–
II.	Incorp.	Many American, Basque.	Algonquin.	–	Corean, Transgangetic, Kiranti, Tibetan.	–	–	–	–
III.	Euphonic	–	–	–	Mandingo, Yoruba.	–	–	–	–
IV.	Euph. inflect.	–	–	–	–	–	–	Haussa.	–
V.	Alliteral	–	–	–	Kongo, etc.	–	–	–	–
VI.	Agglut.	Polynesian,	Narrinyeri.	–	–	–	–	–	–
		Australian.	–	–	Malayan.	Tungusian, Mongolian.	–	–	–
VII.	Agglut. inflect.	–	–	–	–	–	Japanese, Fins, Turkish, Dravidian, etc.	–	Hindustani, Bengali, Singhalese.
VIII.	Dissyl. inflect.	–	–	–	–	–	–	Semitic.	–
IX.	Inflect. synthet.	–	–	–	–	–	–	–	Sanskrit, Zend, Greek, Latin, etc.
X.	Inflect. analyt.	–	–	–	–	–	–	–	Italian, German, English, etc.

language may be indicated, as in chemistry, by a symbol; as, Cβ 1 II. = Corean, Tibetan, etc. — (*Journ. anthrop. inst.*, xiii. 32–52.) O. T. M. [439

Muskoki strategy. — The following method of Indian stratagem is told for the first time by Mr. H. S. Halbert. When a small party of Muskokis wished to attack a Choctaw village, they would arrange themselves in ambush at convenient intervals to within three hundred yards of the village. The bravest man would now crawl up as near the village as practicable, dig a pit and place himself in it, where he would wait until daybreak. The first Choctaw whom he then saw stirring about near his ambuscade he would shoot down, spring forward, and scalp him in the twinkling of an eye. He would then flee toward the second ambuscader. If he was pursued, which was generally the case, the pursuer received the fire of this ambuscader. The two warriors then fled to the third man in ambush. If the pursuers still followed, they received the fire of this man. The three now ran to the fourth ambushed warrior, where the same scene was enacted; and so on until the place of the last man was reached. — (*Amer. antiq.*, v. 277.) J. W. P. [440

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Paleontology. — Mr. Lester F. Ward, paleobotanist of the survey, is at work preparing a catalogue of fossil plants, with their geological relations, which will probably be published during the coming spring. Fifty-one boxes of Fort Union fossil plants, collected by Mr. Ward near Glendive, Montana, last July, have been received at the office of the survey.

A paleontological report on the paleozoic fossils of the Eureka district of Nevada, by Mr. Charles D. Walcott, is almost ready for the press. The number of paleozoic fossils from this district exceeds four hundred species.

During the month of October a large number of Potsdam fossils from Saratoga, N.Y., and some Trenton fossils from Trenton Falls, N.Y., were added to the collections in the hands of Mr. Walcott, who has charge of the department of paleozoic paleontology.

One of the papers in the fourth annual report of the survey is 'A review of the North-American fossil Ostreidae,' by Dr. C. A. White. It will be illustrated by forty-eight full-page plates of figures, giving figures of all the leading species of fossil forms of oysters, and of the leading varieties of Ostrea virginica, for comparison. For it, also, Professor Angelo Heilprin furnishes a revised catalogue of the tertiary oysters; and Mr. John A. Ryder adds a concise life-history of the common oyster, illustrating its anatomy, and giving the results of his recent experiments in the artificial propagation of oysters.

Chemistry. — A laboratory, to be in charge of Prof. F. W. Clarke, is being organized in connection with the survey. Heretofore the chemical work of the survey has been done at various laboratories scattered through the country, and at the field-laboratories at Denver, Salt Lake City, and San Francisco. A laboratory for physical experiments will probably be established in connection with the chemical division.

West-Virginia forests. — During September and October, Col. George W. Shutt examined the southern and eastern portions of West Virginia with especial reference to the distribution of timber, its economic value, and the facilities of transportation to market *viâ* the streams of the region. He travelled over a thousand miles by wagon, and two hundred on horseback, and expresses the opinion that nearly one-half of the state is covered with a virgin forest, the value of which, if rendered marketable, would amount to billions of dollars.

Geology. — In making an excavation a few weeks ago for a building on Connecticut Avenue, in the north-western section of Washington, D.C., the interesting discovery was made of the remains of a subterranean forest. The fact was mentioned at the meeting of the Biological society of Washington, Nov. 2, by Professor Lester F. Ward; and, from the excellent preservation of the wood, the opinion was expressed that it was simply a collection of drift-wood that had been washed into a ravine in comparatively recent time. Mr. W. J. McGee of the Geological survey, who has been working up the geological structure of the District of Columbia for some time, had also examined the locality in question, and was of the opinion that the deposit was of quaternary or prequaternary age. A few days after the meeting of the Biological society, above mentioned, he, with Professor Ward, Mr. G. K. Gilbert, and Mr. J. B. Marcou, re-examined the buried forest; and Mr. McGee's opinion was confirmed, — the stratum was found to underlie the quaternary gravels of the district. The occurrence is of interest, since the slightly altered wood undoubtedly represents the end of the long interval extending from the cretaceous to the beginning of the quaternary, during which the lignite beds and iron-ore deposits, so common in the region, were formed.

Publications. — The survey has just issued a miscellaneous work, one of a series of statistical papers, which is distinct from the Monographs and Bulletins, but, like them, is for sale at cost price (fifty cents in this case). The title of this work is, 'Mineral resources of the United States,' by Albert Williams, jun., chief of division of mining statistics and technology. In its 813 pages it gives the statistics of our mineral production for the year ending June, 1883, and also a mass of information in relation to the production of coal, petroleum, iron, copper, lead, and zinc. It also treats of building-stones, clays, fertilizers, etc., and gives lists of the useful minerals of the United States, with localities, and concludes with extracts from the new tariff relating to import duties upon chemical products, metals, mineral products, etc. It will therefore be seen that the work is of practical value; and this fact is also indicated by the demand for it, which comes largely from miners and mine-owners, particularly from the west.

Bulletin no. 2 of the survey is also by Albert Williams, jun. Its title is, 'Gold and silver conversion-tables, giving the coining values of Troy ounces of fine metal, and the weights of fine metal represented by given sums of United States money.' It is a pamphlet of eight pages, and is of especial value to assayers and bullion-dealers.

The third annual report is printed, and waiting for a few of the illustrations. The fourth annual report, with the exception of the index, is in type. Both these reports will probably be issued early during the forthcoming year.

Dutton's 'Tertiary history of the Grand Cañon district, with atlas' (volume ii. of the Monographs of the survey) has been distributed to European institutions, and will now be distributed to American institutions.

Volume iii. of the Monographs, 'Geology of the Comstock lode and Washoe district,' with atlas, by George F. Becker, is being delivered to the survey by the government printer, and will soon be ready for distribution.

The Monographs of the survey are not for gratuitous distribution. They can only be distributed through a fair exchange for books needed in the library of the survey. Copies over and above the number needed for such exchange are for sale. The price of volume ii. is $10.12, and of volume iii., $11.

NOTES AND NEWS.

Those who are interested in our leading article this week will be pleased to learn, that, in his will, Barrande bequeathed his collections, library, and undistributed copies of his publications, to the museum at Prague. He further provided for the continuation of his work by a bequest of ten thousand florins to the museum, which, by its acceptance, pledges itself to fulfil his wishes. Drs. Krejči, Frič, Kořiska, Prachenský, and Bellot were appointed by him a commission to see that his designs are carried out; and Drs. Waagen and Novák, well-known paleontologists, designated to execute the work, — the former to complete the 'colonies,' gasteropods, and echinoderms; the latter, the bryozoans and corals.

The museum proposes to establish a Barrande fund for supporting further studies on the Silurian formation of Bohemia; and any gifts that may come from America for that purpose would, we are assured, be deemed particularly valuable. The editor of Science will be pleased to forward to the museum at Prague any contributions that American naturalists may desire to make, and to acknowledge the same in these columns.

— Sir Charles William Siemens died in London, Nov. 20. He was born at Leuthe, in Hanover, in 1823. From 1844 he resided in England. In 1858 he established, with his brother, the firm which has become famous through the telegraph-cables they have made. For ten years (1853-63) Dr. Siemens was engaged on the regenerative gas-furnace, and since that time his methods of manufacturing steel have met with the greatest success.

— Information has been received from Sunda Straits, giving details of the hydrographical and topographical changes due to the great Java earthquake. These seem to be less extensive than heretofore reported by the press. Commander P. F. Harrington, U.S.N., reports the hills and trees in the vicinity of St. Nicholas Point covered with ashes, but otherwise unchanged. The soundings here remain the same. The sea has rushed through the valleys of Thwartway Island, tearing away the vegetation, and leaving the low land bare; and, from a distance, these breaks in the forest give it the appearance of five islands, but there is no change in the shore-line or soundings. The same is true of Anjer, where the base of the lighthouse at Fourth Point, and the buoys of the submarine cable, are the only monuments of that populous town. The plains have been swept by the sea, and show only uprooted palms, and ghastly relics of the inhabitants. Krakatoa volcano appeared active; but on a nearer approach it was found that the appearance resulted from ashes, etc., falling down the precipitous cliffs, and carried off by the wind.

The north-western part of Krakatoa Island has disappeared. The immense mass which is missing seems to have formerly been the choked-up crater; and its material has probably modified the sea-bottom northward from its place. No bottom could be found in the vacant spot with twenty fathoms of line. Prior to the eruption, Verlaten and Lang islands were covered with verdure. Their contour has been but slightly changed, but they are covered with scoria. A small island has formed eastward from Verlaten. The Polish Hat has disappeared, and where it stood is more than twenty fathoms water. A new rock, about twenty feet in height, has risen in eight fathoms, near the southern point of Lang Island. The channel south from Bezee Island has been closed to navigation by reefs and islets not yet surveyed. From the northern end of the island a reef extends in a north-westerly direction, apparently connecting with other islands to the westward.

The whole coast of Java between Second and Fourth points has been swept clean by the sea, but there is no essential change in the shore-line and soundings. Masses of floating pumice are wedged in Lampong Bay, and interrupt communication with Telok Betong. The lighthouse at Java Head remains undisturbed, as does that at Flat Point. Other dangers may be developed on a careful survey, but the main gate of the Straits of Sunda seems unimpeded.

— Mr. W. F. Denning of Bristol, Eng., noting the fact that accounts of large meteors form a frequent subject of correspondence in the columns of scientific journals, but that it is not often the case that the descriptions of these phenomena are sufficiently exact to be valuable for purposes of calculation, suggests, in a letter to the editor of *Nature*, the proper methods of useful observation of these bodies. Rough estimates of the direction and position of flight are of little utility; and the vague statements often made occasion an endless source of difficulty in the satisfactory reduction of results. The observers of large meteors should attend scrupulously to that most essential detail, the direction of flight, and express it by some method of uniformity. In place of the customary vague and variable methods of description of the apparent paths of these bodies, Mr. Denning suggests that observers uniformly give the right ascension and declination of the beginning and end points of the visible paths, — elements which admit of ready determination by projecting the observed flights upon a star-chart or celestial globe, and reading them off. This system would render the after-comparison of observations a work of greater facility and precision. Though the direction of flight is the all-important element to be determined by meteor-observers, some minor points — as the time of appearance, brightness, and approximate duration — should be recorded whenever feasible; also whether the body is accompanied by phosphoric streaks or spark-trains. If this were done more systematically, the observations of fireballs would acquire additional value, and quite possibly might develop some new facts either as to their appearance or origin.

— Mr. Thomas Gaffield read a paper on glass and glass-making, illustrated by specimens, at a meeting of the Society of arts of the Massachusetts institute of technology, Nov. 22.

— At the meeting of the Portland, Me., society of natural history, Nov. 19, the president, Dr. Wood, gave account of the unearthing of bones of some unknown animal from a peat-bed on Ragged Island, Casco Bay, by Capt. Thomas Skolfield in 1835. Eighty-five feet in length of vertebral bones were taken out and thrown away. The head and tail were not uncovered, and the animal was estimated to be a hundred and ten feet long. No ribs were found, and no marks of rib attachment appeared on any of the vertebrae, which were hard and smooth. Only four bones were saved: two were given to the Portland society, but were burned in 1854; the other two have been lost sight of, but were said to have been taken to the Philadelphia academy in 1836 or 1837, by a Mr. Coolidge. Of the two given to the society, the large one was unquestionably a vertebra: its length was from fourteen to sixteen inches; its diameter, nine or ten inches on the articular faces, and eight midway. The other bone was limpet-shaped, four or five inches in diameter and height. The shape and size of these bones are well remembered by members of the society, and Capt. Skolfield; and the story of the last is well vouched by many others.

Two unsuccessful attempts have been made by the society to unearth more bones. Another trial will be made next season.

— On the retirement of Mr. R. Hering from the presidency of the Engineers' club of Philadelphia, at the close of its fifth year, he gave a summary of recent progress (*Proc. eng. club Philad.*, iii.). The work of the late U. S. board appointed to test iron, steel, and other metals, was referred to; and it was stated that there was at least some possibility that its work may be in time resumed. The chief of ordnance recommends that an appropriation of ten thousand dollars be made by Congress for the purpose, as urged by the convention of the societies of civil, mechanical, and mining engineers. The differentiation of the profession into the several branches, — civil, mechanical, mining, — and the subdivision of these into specialties, were considered as marking the tendency of recent change. Inventions are coming forward with increasing number and rapidity, but it is becoming each day more evident that they are all the products of growth and of gradual development. No new thing comes into use at once fully perfected. Of accomplished work, the East-river bridge, with its span of 1,595 feet, suspended 135 feet above the water; our Kinzua viaduct at Bradford, 2,052 feet long, spanning a valley 302 feet below it; the Henderson bridge over the Ohio, of 525 feet span; and the great bridge to be built over the Firth of Forth, — are among the most marvellous. The great canals in progress, or proposed, — that in Florida, opening the Kickpochee Lake; the interoceanic canal through the Isthmus of Panama; the great Sirhund canal in India, 500 miles long; the Corinth canal in Greece; and the Manchester ship-canal, — are evidences that the days of canals are but just commencing. The United States boast to-day 116,000 miles of railroad, and are building over 30 miles per day, and earning $550 per mile. Locomotives for the Pennsylvania railroad are built weighing over 60 tons, and make 90 miles in 80 minutes. Electricity is a competitor, which, however, is not likely at once to displace steam on the rail. Heat and steam supplied from a central station, as at New York, where the New-York steam company are preparing to work 16,000-horse power of Babcock & Wilcox boilers, 2,000-horse power of which are constantly at work, is a promising illustration of advance. Electricity similarly distributed, — as by the Edison company and the Brush company, — and the telephone, are the latest of these achievements of the profession. Sanitary engineering, although the most essential of all, seems to be the last to come in, and is but now beginning to take its place.

— Since the article in this number on crystals in the bark of forest-trees was in page, the writer has seen a recent work, Anatomie der Baumrinden, Berlin, 1882, Dr. Joseph Moeller, in which the subject is fully treated and richly illustrated.

— Microscopists will regret to learn of the death of Mr. Robert B. Tolles at Boston, on the 17th, at the age of sixty-one. No one has done more than he to raise the standard of excellence of American objectives for the microscope; and his ingenuity in devising special methods to overcome particular difficulties is known to all who have tested his powers. He has been in feeble health for several years, but continued to work with astonishing vigor and pertinacity.

SCIENCE.

FRIDAY, DECEMBER 7, 1883.

JOACHIM BARRANDE.

II., HIS SCIENTIFIC WORK.

The influence of Barrande upon science in this country and throughout Europe has been of the first importance; and he has done much for the reputation of many of our investigators by his careful attention to their works, and his respectful quotations. He recognized the work especially of Dr. E. Emmons, and gave him the credit of being the discoverer of the primordial fauna, which Emmons had previously published as being in the Taconic system. Barrande thus ranged himself, during the celebrated Taconic controversy, on the side of Dr. Emmons, and his principal supporter in this country, Professor Jules Marcou. One of M. Barrande's most remarkable discoveries related to what he has called 'colonies.' According to him, certain characteristic fossils appeared sporadically in the faunas preceding those to which they properly belonged; and he deduced from this the result that two faunas having some identical species, but existing in different parts of the world, were not necessarily contemporaneous because of this fact, but might, indeed, be very distinct in age. These views are strongly supported by Professor Jules Marcou in this country, who states that he has discovered similar colonies in the rocks of the Taconic, underlying the Potsdam at Swanton and Phillipsburg; and is opposed principally by English authors upon the grounds that the evidence was stratigraphically defective. Barrande's reply to this, which he was preparing at the time of his death, has not yet been published. The theory has the support of the geologists of Vienna, especially Haidinger, director of the Imperial museum, whom Barrande quotes upon the titlepage of each of his books upon the 'colonies.'

From 1846 to the present time, the smaller publications of this voluminous and accurate writer must have reached nearly a hundred. Of these, between seventy and eighty were made to learned bodies, and from sixteen to twenty were pamphlets and books of octavo size: some of these were abridgments of his larger volumes. In the latter series, his *études*, extracts, etc., he published over three thousand pages and twenty-nine plates. Of these, his 'Cephalopodes, études générales,' was the most important to the general student. His grand work, the publication of which was begun in 1852, and is not yet finished, has already reached, as we have said, the number of twenty-two quarto volumes. These treat of the Trilobites and Crustacea, 1,582 pages, 84 plates; Cephalopoda, 3,600 pages, 544 plates; Brachiopoda, 226 pages, 153 plates; Acephala, 342 pages, 361 plates; and he announces as having already completed over 100 plates of the Gasteropoda, which have not yet appeared. This makes the enormous number of 5,750 pages of text in quarto, and 1,148 plates already issued, which we estimate as containing about eighteen thousand figures of fossils of the finest execution.

Barrande published large editions of his smaller works, which he distributed with a free hand to many institutions and scientific men; but of his larger works, the edition, probably on account of the expense, was limited to two hundred and fifty copies. The larger number of these he also gave away to scientific institutions and to individual geologists, and it is estimated that he did not receive in return as much as the actual cost of three of the large volumes.

The Gasteropoda, Echinodermata, Bryozoa, and miscellaneous fossils still remain unpublished; though over a hundred plates of the Gasteropoda were completed, and the text was being printed, at the time of his death.

The number of species described amount to thirty-six hundred. When we reflect that each of these had to be studied, and handled over and over again many times, before reaching the final stages of classification, description, and illustration, we are amazed at the industry and capacity required to do all this scientific work single-handed. Barrande, unlike other voluminous authors, had no collaborators. With the exception of an amanuensis, draughtsmen, mechanical preparators, and mere collectors, he did all of this vast work. A careful and comprehensive system was followed in every volume, and in the descriptions of each species; so that, when one has mastered the intricacies of this, he can at once find every thing relating to the history, literature, structure, relations in time, and geographical distribution, of any species or group.

Finally, in the cephalopods, the parts and internal structures for which this fossil type is remarkable, as well as the embryo shells and their characteristics, are followed out in the same way. We will speak more at length of this type, partly because it was the favorite and most fruitful field of research of this eminent author, and was selected by him as the stronghold from which to attack the theory of evolution, and partly because we have no space to do justice to other departments, where he, however, made important discoveries; as, for example, among the trilobites. With infinite labor he succeeded in getting series showing the stages of growth of some species among these ancient Crustacea, and taught us that it was possible to study their development even in the Silurian period. Barrande's efforts have been frequently referred to as if he were one of what we might call the numismatic school of geologists, who study animal fossils as if they were medals, useful principally to verify the date and place of formations. On the contrary, his technical labors had a distinctly ideal purpose, — the investigation of the evidences for and against the theory of evolution. His education and consequent psychological condition placed him in opposition, and, in spite of his honest efforts to treat the subject fairly, controlled his classifications, and warped his judgment. The Cuvierian form of anthropomorphology was his faith; and he failed, as have most great executive men, in realizing the dangers of his own mental training, and the need of correcting the personal equation.

The facts, however, were strong enough even to meet his requirements in some of the groups he studied; yet he ended by admitting that evolution must, in part at least, be true. He believed that the different types were miraculously created, but that the smaller series which he had traced might have been evolved within certain well-defined limits, fixed according to the plans of an infinite intelligence, which it was hopeless to try to understand. He was also deficient in that sort of zoölogical knowledge which is acquired only by research among existing animals, and a familiarity with their modes of development, anatomy, and habits. This explains the apparent inconsistencies which show themselves in his text: — the continual admission of transition forms between different species and smaller groups, and yet the perpetual denial of the probable former existence of any such transitions between what he considered distinct types, whenever he could not actually find them; his comparisons between the Silurian and recent Nautili, which he supposed to be very similar, when in reality only their adults are similar, the young shells and their developmental stages being widely different; his singular opinion that species like these Silurian Nautili and other forms, which seemed to him out of place and also inexplicable on account of their structure, had been set in the geological record as intentional exceptions, to teach man the divine origin of this apparently modified chaos of gradations. Barrande understood, and gave a fair statement of, the ordinary views of evolutionary embryologists on p. 74 of his 'Études générales, Cephalopodes,' and represented a naturalist of this stamp investigating the embryos of the fossil Nautiloidea. After finding all the forms of the group from the Silurian to the present time with the same type of apex or young, he would then necessarily draw from this embryo a picture of the lost prototypical ancestor of all the Nautiloidea. In his next steps he would find the adults of transition forms from Nautiloidea to Ammonoidea, and set down his convictions that the Ammonoidea must have been derived from Nautilus through these transition forms, the gradations being Nautilini, Goniatites, Ammonites. Barrande then pictures this same naturalist as attempting to verify his apparently well-founded conclusions by opening a species of Goniatite with the anticipation of discovering within, at the apex, or young shell, an identical form and structure to that which he had been accustomed to find in the Nautiloidea, and his consequent confusion, and the overthrow of his theory, upon the exposure of a different form. Barrande's argument deals fairly with every point; and his facts are crushing refutations of the usual direct, simple modes pursued by embryologists in handling the question of the evolution of types. Barrande's work had no orators or lecturers to translate it; and the hypothesis of the embryologists, and even evolution itself, escaped an attack, which, if supported by powerful influences, might have shaken the popular faith in the new school of thought.

Hyatt has denied that there were such great and essential differences between the embryos of the Nautiloidea and those of the Ammonoidea; and they certainly seem to have been more alike than was supposed by M. Barrande. The fact, however, remains, that Barrande saw clearly that the embryos of these two nearly allied groups, which are united by most authors into one order, were, even in the Silurian, more easily separable from each other than some of the adult forms. When we can add to this, his discovery and thorough demonstration of the distinctness of the different types of fossils in the Silurian, and their sudden mode of appearance, we see clearly that he succeeded in doing the work which has thrown the greatest light upon the most obscure and interesting periods of the world's history, and which has furnished a temperate and healthy opposition to the theory of evolution. His faults of logic were unavoidable, with his mathematical and Cuvierian education, and strong feelings of loyalty to his masters in science; but these are only slight scratches upon the face of the vast monument erected by his labors, his discoveries, his eighty-three years of unblemished moral and faithful life, and his personal sacrifices for the advancement of science and the truth.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — V.

CYCLONIC circulation has thus far been described as if it were effected in radial lines in to and out from the centre; but here, as in the whirlwind, perfect radial motion is impossible. A horizontal rotary motion would soon be established near the centre by the inequality of the inblowing winds. It is found, however, that all storms yet studied turn from right to left in the northern hemisphere, and from left to right in the southern (fig. 9). Such constancy points to something more regular than the accidental strength of the winds,—to some cause that shall always turn the indraughts to the right of the centre as they run in towards it in the northern hemisphere, and to the left in the southern hemisphere; and this cause is found in the rotation of the earth on its axis.

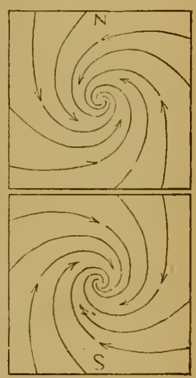


FIG. 9.

There is a force arising from the earth's rotation that tends to deflect all motions in the northern hemisphere to the right, and in the southern to the left; and this deflecting force varies with the latitude, being nothing at the equator, and greatest at the poles. It may be found that this statement differs from that generally made; namely, that moving bodies are deflected only when moving north or south, and not at all when moving east or west; for it is thus that Hadley (1735) and Dove (1835) explained the oblique motion of trade-winds, and that Herschel and others explained the rotation of storms. But this is both incorrect and incomplete; for a body moving eastward is deflected as well as when moving northward, and the actual deflective force is greater than that accounted for in Hadley's explanation.

[1] Continued from No. 43.

It is this deflective force, acting on winds from all sides, as was first shown by Tracy[1] (1843), that combines with the centripetal tendency of the surface-winds to give rise to the inward spiral blowing of the storm (fig. 10), — a constant feature of all cyclones.

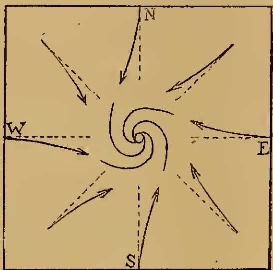


Fig. 10.

In all hurricanes, the winds greatly increase in strength as they near the centre of the storm, and at the same time their path becomes more nearly circular. A cause of this was briefly stated for the whirlwinds: but it now must be more fully analyzed; and it will be best to begin the attempt by resolving the motion of the wind at any point of its spiral track into two rectangular components (fig. 11), — one, along a radius toward the centre, *P R*, the centripetal component; the other, circular or tangential, *P T*. Only the first of these comes directly from the convectional circulation, already described as depending on the central warmth; and this one would never produce winds of devastating strength. The second, or tangential, arises first from the deflective force of the earth's turning. The higher the latitude, the less the friction at the bottom of the atmosphere, and the greater the distance from which the wind is derived, then the greater its right-handed departure from a radial path. Hence in a large storm at sea, where the friction is small, and the indraught has its source several hundred or even a thousand miles away from the centre of low pressure, the deflective tangential component becomes very considerable, and may, near the centre, outrank the centripetal.


Fig. 11.

But there is another and even more important cause of growth in the circular element of the wind's motion; namely, the increase of its rotary velocity as the radius of rotation decreases, in accordance with the law of the 'preservation of areas,' already mentioned. Let us suppose, that, when at a distance of five hundred miles from the centre, the inblowing wind has been turned to the right of its radial path by the earth's deflective force so as to have the moderate tangential or rotary velocity of one mile an hour; and, disregarding the further effects of deflection, let us consider the consequences of gradually drawing this mass of air towards the centre. The product of its radius and its rotary velocity must remain constant; and hence, as the radius is diminished, the velocity must increase, one quantity varying inversely as the other. The wind has no visible, material connection with the storm-centre; but it is slowly moving around that centre, under the control of central forces, derived from differences of temperature and pressure, that drive it inwards, or, in other words, shorten its radius of rotation: and consequently, when, in the case supposed, the radius has been diminished to five miles, the velocity must have been accelerated to one hundred miles an hour, — a violent hurricane-wind. The recognition of this important factor of the storm's strength is due to Ferrel (1856). The theoretical increase of velocity thus provided is never fully realized, for much motion is overcome by friction; but enough is preserved, especially in tropical storms, to give them the greatest share of their destructive strength. The total tangential component of the wind at any point must therefore be considered as the sum of the deflective and accelerative forces, minus the loss by friction. Near the storm-centre, where the velocity of the wind is very great, this tangential component is much greater than the centripetal, and the spiral path becomes almost circular; while the reverse relation holds for the outer part of the storm.

It will be easily understood, that a considerable centrifugal force will be developed by the rapid central rotations, as well as by the earth's deflective force; and, as a consequence, the centripetal force will be partly neutralized, and the winds will be held out from the centre. This must increase the depression already produced there by expansion and overflow; and, as a matter of fact, the low pressure of a storm-centre, especially in tropical latitudes, is chiefly the effect of this dynamic, and not of the earlier named static cause. But so long as the wind maintains its rapid motion, the additional

[1] See Science, i. 98.

depression is powerless to draw it towards the centre. Only when its velocity is decreased by friction does the barometric gradient, just before produced by the centrifugal force, urge the wind inwards to the middle of the storm. The additional gradient, therefore, represents potential energy, derived from the actual energy of the rotating winds, and all ready to be transformed into actual energy again, as soon as friction has destroyed some of the velocity of rotation.

The general interaction of the storm-forces may now be thus summarized: in obedience to a centripetal tendency, produced by differences of temperature or of pressure, or both, the air moves along the surface to the region of low pressure. On its way, the deflective force arising from the earth's rotation turns it continually to one side, and so gives it a more and more nearly circular path; and, in addition to this, its rotary velocity increases as much as its radius of rotation decreases: the tangential component of its spiral motion must therefore continually increase. With the increase of this component, and the decrease of the radius of rotation, the centrifugal force ($v^2 \div r$) must increase rapidly, and soon come to equal and counterbalance the original centripetal force, and at the same time greatly increase the barometric gradients. At this point the wind would blow in a circular path, were it not that friction with the sea or ground is continually consuming some of its velocity, and thus decreasing its centrifugal force, and allowing the potential energy of the steep barometric gradient to produce centripetal motion. This decreases its radius, and at once gives it new life, again to be partly destroyed and renewed as before. Absolutely circular motion can therefore never be attained, although it is approached very closely near the centre. At sea, where friction is small, and in tropical latitudes, where the strength of the storm is great, the wind is unable to reach the storm-centre; for, when the distance from the centre is reduced to only five or ten miles, the centrifugal force is so great, and the wind's course is so nearly circular, that it is carried aloft by the up-draught before it can enter noticeably farther: the central area is therefore left unprovided with violent winds, and is generally a comparative calm, known as the 'eye of the storm,' of which there will be more to say later. The general form of the storm-wind's spiral can be deduced from the preceding considerations. The angle between the tangential component and the actual path of the wind, which is called the inclination (fig. 11.), will vary with the relation of the circular and centripetal elements of the wind's motion; the tangent of the inclination will equal the radial divided by the tangential component: hence in the outer part of the storm the inclination will be large, and the wind will blow almost directly toward the storm-centre; but nearer the centre the inclination will become smaller and smaller, and the wind will blow in a more and more nearly circular path. It will also be understood, that the upper winds, less influenced by friction, will near the centre have a greater velocity and a less inclination than the lower ones. Moreover, the inward gradient which they produce will be effective and important in urging along the slower surface-winds, in a manner better illustrated in a tornado, where this action will be more fully described.

(To be continued.)

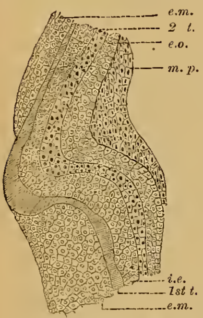
ON THE DEVELOPMENT OF TEETH IN THE LAMPREY.

The teeth in the myxinoid fishes are quite different from those of other vertebrates, and have hitherto been supposed to belong in an entirely different category. Nothing has been known with regard to their development, except a brief statement as to their mode of succession in Petromyzon by Professor Owen, in his 'Odontography.'

The teeth of the lamprey are horny, and of simple conical shape, disposed concentrically in the dome-shaped mouth. Besides these, there are horny lingual and palatal teeth.

The kindness of my friend Professor Benecke of Königsberg, who sent me a number of lampreys at the end of their metamorphosis from Ammocoetes, has enabled me to follow out the development of these horny teeth with unexpected results; for, as far as the essential part of the process is concerned, it differs but slightly from the normal course of true dental development. There is first formed a low conical papilla of somewhat reticulate tissue, belonging to the mesoblast (*m.p.*), and continuous with the dermis, which in this, as in other vertebrates, is of mesoblastic origin. Over this papilla the epiblast which lines the cavity of the mouth becomes extremely thick, and consists of very numerous layers of cells. All of these layers can be continuously traced into the other epiblast of the mouth, as well as that of the external skin. In the stage here figured there may be seen, immediately overlying the mesoblastic papilla, a layer of epiblastic cells irregularly columnar and polygonal in shape (*e.o.*). These cells are the homologue of the enamel-organ of the other vertebrates, and originate in the same way. So far, at least, the lamprey does not show an essentially different type of tooth-development from that known in other groups.

The cells of the 'enamel-organ' are rapidly proliferating, and have thrown off from their outer surface a conical cap of cells (*2d t.*), which are flattened, and which show an incipient formation of pigment among them. This hollow cone of cells is the rudiment of the youngest tooth, which in the stage here described is the second of the series. Outside of the rudimentary tooth is a cone of polygonal epiblastic cells, several layers deep (*i.e.*); and this is again followed by the first tooth, now almost completely cornified and pigmented, so that traces of cellular structure are but faintly discernible (*1st t.*). The tip of this tooth has just penetrated the skin of the mouth, and is elsewhere covered by the many-layered epiblast (*e. m.*).



Section through inner side of lip of metamorphosing lamprey. *e.m.*, epiblast of mouth; *1st t.*, oldest tooth; *2d t.*, youngest tooth; *e.o.*, enamel-organ; *i.e.*, intermediate epiblast-cells between successive teeth; *m.p.*, mesoblastic papilla.

We see, therefore, that the essential parts of the typical vertebrate tooth are here present; namely, the mesoblastic papilla, and the over-lying epiblastic enamel-organ. But the ordinary type of dental development is here greatly modified. The papilla is never ossified; and the enamel-organ secretes no enamel, but functions as a sort of tooth-gland, throwing off successive hollow cones of flattened and cornified epiblastic cells. The actual tooth of the lamprey is therefore not the homologue of the entire tooth of a selachian, but simply of the enamel-cap. It is not difficult, however, to understand how the process seen in Petromyzon could be derived from that in the selachian. In consequence of this change, another difference arises: as the papilla never ossifies or becomes protruded, it is no longer necessary that for every new tooth a new enamel-organ should be formed by budding from the old one; so each enamel-organ is converted into a permanent tooth-gland, functional throughout the life of the animal.

This view of the peculiarities of dental development in Petromyzon implies, of course, that this group of fishes was derived from ancestors possessed of teeth of the ordinary or selachian type. Further, as it is now very generally admitted that teeth are only modified placoid scales, it follows that the lampreys are descended, ultimately at least, from forms provided with placoid scales.

Such a conclusion, however, does not by any means commit us to the view that the myxinoids are degenerate descendants of some gnathostomatous group, as this is no more implied in the possession of ordinary calcareous teeth than in the presence of the horny teeth which the group has long been known to possess.

W. B. SCOTT.

Morphological laboratory, Princeton, N.J.,
Nov. 3, 1883.

NORDENSKIÖLD ON THE INLAND ICE OF GREENLAND.[1]

In a series of letters to Mr. Oscar Dickson, Baron Nordenskiöld has given a detailed report of the leading incidents and results of his recent expedition, though it will still be some time ere we can learn what are the full gains to science. The leading novelty of the expedition was, of course, the journey into the interior of Greenland.

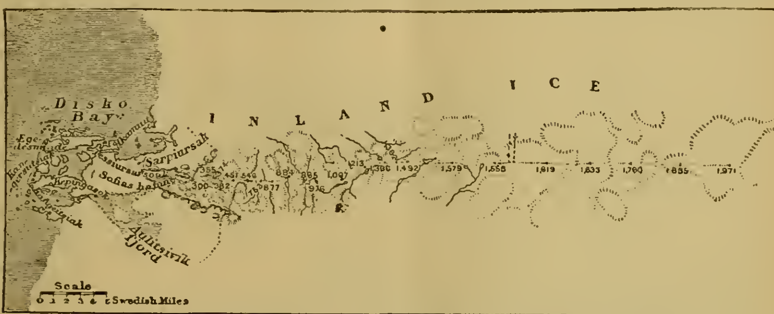
After landing Dr. Nathorst and his party at Waigatz Sound, Nordenskiöld went back to Egedesminde, which he reached on June 29. The following day he left for Auleitsivik Fjord, from which the expedition was to start. He then proceeds: —

On July 1 the Sophia anchored in the bay. We found here a splendid harbor with clay bottom, some seven fathoms deep, surrounded by gneiss rocks from six hundred to a thousand feet in height, the sides of which are in some places covered with low but close shrubs, or clothed with some species of willow, mosses, and lichen, which, when we arrived, were ornamented with a quantity of magnificent blossoms. From one of the slopes a torrent descended, the temperature of which was 12.3° C. The weather was fine, the sky cloudless, and the air very dry. July 1 to 3 were employed in making preparations for the ice-journey, while the naturalists made excursions to various places in order to collect objects relating to the conditions of the country. On the night of the 3d every thing was ready for a start; and, after some difficulty in reaching the spot where the baggage was, we were fairly off. The spot from which we set out on the journey was only five kilometres from the actual shore, and situated below a little lake into which a number of glacier rivers fell. We proceeded up the river in a Berton boat, purchased in England. On the night of the 4th we camped for the first time on the ice. The expedition consisted of nine men besides myself. After a great deal of hard work in getting the sledges over the ice, which was here very

[1] From *Nature*, Nov. 1 and 8.

rough, we found, on the morning of the 5th, that it was impossible to proceed eastwards, but were compelled to return to the border of the ice, and then continue to the north or north-east until finding smoother ice. This first part of the ice was furrowed by deep crevasses and ravines, causing us much trouble. We covered, however, a good distance that day, and pitched our tent near a land-ridge in the ice, two hundred and forty metres above the sea.[1] On July 6 I sent the Lapp Lars forward to reconnoitre; and he reported that it was still impossible to proceed eastwards, but, if we marched for a day or so to the north, we would find the country accessible to the east. As I feared, however, the impossibility of dragging the sledges with the weight on them over the rough ice, I selected provisions, etc., for forty-five days, and left the rest in a depot in the ice. We now resumed the march. It was very interesting to witness the great ease with which the Lapps proceeded among the ice-ravines, how easily they traced a road discovered, and with what precision they selected the least difficult track.

The Lapp Lars carried, instead of an alpenstock, a wooden club, with which he had slain more than twenty-five brown bears, full of marks from their teeth; and his eyes sparkled at the thought of encountering a white one. On the night of the 6th we held our third camp on the ice; and now several officers and men from the Sophia, who had accompanied us thus far, left us. Besides the most advantageous requisites for such a journey, we had with us a cooking-apparatus for petroleum: and here I beg to say that I found this kind of oil far more suitable than train or vegetable oils, which I had used on my former expeditions; and I recommend the same most warmly to arctic explorers. Of scientific instruments I may mention compasses, two chronometers, a circle by Pistor and Martin, a small sextant (in case of the former being damaged), a mercury horizon, three aneroid barometers, thermometers, magnets (for the study of the clay deposit in the snow), a topographical board, a photographic apparatus, blowpipes, flasks, nautical tables, etc. The sledges, 'kalkar,' six in number, were of the same kind as those on which Swedish peasant women bring their wares to market. The harness was made so strong that it would hold a man, in case of his falling into a crevasse. In addition to these things, we had a Manila rope specially spun for the expedition at the Alpine purveyor's in Paris. The food supplied per day may perhaps interest explorers. It was, — breakfast, coffee, bread, butter, and cheese (no meat or bacon); dinner, forty-two cubic centimetres Swedish corn brandy (*bränvin*), bread, ham or corned beef, with sardines; supper, preserved meat, Swedish or Australian. Sometimes preserved soup was served with dried vegetables. Five men were teetotalers, but there was no need of supplying them with extra rations. For cooking, 0.7 litres of spirits were consumed per day. Our whole baggage weighed a ton, — a weight which might easily have been drawn across a smooth snow or ice field, but which was very difficult of transporting over the rough and cut-up surface we had to traverse. Our daily march between July 7 and 9 was therefore not great, viz., five kilometres a day. In addition to the crevasses and ravines, we encountered innumerable rivers, swift, and with steep banks, which were difficult of crossing, which was generally accomplished by laying three alpenstocks across them. If I had not selected these of the toughest wood obtainable, we should often have had to make *détours* of many kilometres.



THE HEIGHTS ARE GIVEN PROVISIONALLY IN METRES. SWEDISH MILE = 6.64 ENGLISH MILES.

On these days we found, on several occasions, large bones of reindeer on the snow; and it was but a natural and pardonable conclusion to arrive at, that they were those of animals who had fallen in their wandering over the 'Sahara of the arctic regions.' But that good signs are not always true ones we soon discovered.

[1] The altitudes were ascertained by comparing three aneroid barometers, while observation was simultaneously made at Egedesminde with a splendid sea-barometer I had left there for that purpose. As the figures have, however, not yet been verified, they may be slightly altered. They seem, on the whole, too low.

During the entire journey, we had great difficulty in finding suitable camping-places. Thus, either the ice was so rough that there was not a square large enough for our tent, or else the surface was so covered with cavities, which I will fully describe later on, that it was necessary to pitch it over some hundred smaller and a dozen larger round hollows, one to three feet deep, filled with water, or else to raise it on a snow-drift so loose and impregnated with water that one's feet became wet, even in the tent. An exception to this was the place where we camped on July 9; viz., camping-place no. 6. We encountered here a small ice-plain, surrounded by little rivers, and almost free from cavities, some thirty metres square. All the rivers flowed into a small lake near us, the water from which rushed with a loud roar through a short but strong current into an enormous abyss in the ice-plateau. The river rushed close to our tent, through a deep hollow, the sides of which were formed of magnificent perpendicular banks of ice. I had the spot photographed; but neither picture nor description can give the faintest idea of the impressive scene, viz., a perfectly hewn aqueduct, as if cut by human hand in the finest marble, without flaw or blemish. Even the Lapps and the sailors stood on the bank, lost in admiration.

At first we had followed the plan of bringing the baggage forward in two relays; but, finding this very fatiguing, I decided to bring all with us at once. I found this to answer better. On July 10 we covered thus nine and a half, on the 11th ten, and on the 12th eleven, kilometres. The road was now much better than before, although stiff enough. An exception to this was, however, formed by the part we traversed on the 11th, when we proceeded alongside a big river, the southern bank of which formed a comparatively smooth ice-plain, or rather ice-road, with valleys, hills, cavities, or crevasses, some five to ten kilometres in width, and five kilometres in length. This plain was in several places beautifully colored with 'red' snow, especially along the banks of the river. It was the only spot on the whole inland ice where we found 'red' snow or ice in any quantity. Even yellow-brown ice was seen in some places; but, on the other hand, ice colored grayish-brown or grayish-green, partly by kryokonite, and partly by organisms, was so common that they generally gave color to the ice-landscape.

Even on July 12, between camps nos. 7 and 8, we found blades of grass, leaves of the dwarf-birch, willows, crackberry, and pyrola, with those of other Greenland flora, on the snow. At first we believed they had been carried hither from the interior; but that this was not the case was demonstrated by the circumstance that none was found east of camp no. 9. The only animals we discovered on the ice were, besides the few birds seen on our return-journey, a small worm which lives on the various ice algae, and thus really belongs to the fauna of the inland ice, and two storm-driven birds from the shore. I had particularly requested each man to be on the lookout for stones on the ice; but, after a journey of about half a kilometre from the ice-border, no stone was found on the surface, not even one as large as a pin's point. But the quantity of clay-dust ('kryokonite') deposited on the ice was very great, — I believe, several hundred tons per square kilometre.

We now ascended very rapidly, as will be seen from the subjoined statement of our camps: —

3d	camp,	300	metres above	the sea.
4th	"	355	"	"
5th	"	374	"	"
6th	"	382	"	"
7th	"	451	"	"
8th	"	546	"	"
9th	"	753	"	"

The 9th camp lay on the west side of an ice-ridge close by a small, shallow lake, the water from which gathered, as usual, into a big river, which disappeared in an abyss with azure-colored sides. From this spot we had a fine view of the country to the west, and saw even the sea shining forth between the lofty peaks on the coast; but, when we reached east of this ice-ridge, the country was seen no more, and the horizon was formed of ice only.

Through an optical illusion, dependent on the *mirage* of the ice-horizon, it appeared to us as if we were proceeding on the bottom of a shallow, saucer-shaped cavity. It was thus impossible to decide whether we walked up or down hill; and this formed a constant source of discussion between us, which could only be decided by the heaviness of the sledges in the harness. The Lapps, who seemed to consider it their sole business that we should not be lost on the ice, came to me in great anxiety, and stated that they had no more landmarks, and would not be responsible for our return. I satisfied them, however, with the assurance that I would find the way back by means of a compass and solar measurements. In spite of this, the Lapps easily traced our route and our old camps with an accuracy quite marvellous.

During our outward journey, I determined the site of each camp astronomically; and thus the distances which, when the determinations have been calculated, will be given on the map to be drawn of the journey, will be absolutely correct. But the distances covered by the Lapps have been made according to their own judgment. The kilometres we covered every day, including the numerous *détours*, were ascertained by two pedometers.

Up to the 9th camp we were favored by the finest weather, generally with a slight south-east wind, cloudless sky, and a temperature in the shade, three feet above the ice, of 2° to 8° C., and in the sun of even 20° C. The centre of the sun's disk sank in this spot for the first time below the horizon on July 15, and the upper rim, if allowance is made for refraction, on July 21. After the middle of July, when at an elevation of four thousand to seven thousand feet, the nights became very cold, the thermometer sinking to 15° and 18° below freezing-point of Celsius.

The constant sunshine by day and night, reflected from every object around, soon began to affect our eyes, — more so, perhaps, because we had neglected to adopt snow-spectacles at the outset of our journey; and snow-blindness became manifest, with its attendant cutting pains. Fortunately Dr. Berlin soon arrested this malady, which has brought so many journeys in the arctic regions to a close, by distributing snow-spectacles, and by inoculating a solution of zinc vitriol in the blood-stained eyes. Another malady — if not so dangerous, at all events quite as painful — was caused by the sunshine in the dry, transparent, and thin air on the skin of the face. It produced a vivid redness and a perspiration, with large burning blisters, which, shrivelling up, caused the skin of the nose, ears, and cheeks, to fall off in large patches. This was repeated several times, and the pain increased by the effect of the cold morning noon of July 13, with a heavy wind from south-east. It continued all the night, and the next morning turned into a snow-storm. We all got very wet, but consoled ourselves with the thought that the storm coming from south-east argued well for an ice-free interior. When it cleared a little, we strained our eyes to trace any mountains which would break the ice-horizon around us, which everywhere was as level as that of the sea. The desire soon 'to be *there*' was as fervent as that of the searchers of the Eldorado of yore; and the sailors and the Lapps had no shadow of doubt as to the existence of an ice-free interior; and at noon, before reaching camp no. 12,

Fissure in Greenland's inland ice, seen by Nordenskiöld on his visit in 1876. From a sketch by Dr. Berggren, published in *La Nature*.

air on the newly-formed skin. Any similar effect the sun has not in the tropics. With the exception of these complaints, none of us suffered any illness.

On July 13 we covered thirteen, on the 14th ten, and the 15th fourteen, kilometres (9th to 12th camps). At first the road gradually rose; and we then came to a plain, which I, in error, believed was the crest of the inland ice. The aneroids, however, showed that we were still ascending: thus the 9th camp lies 753, the 10th 877, the 11th 884, and the 12th 965, metres above the sea. Our road was still crossed by swift and strong rivers; but the ice became more smooth, while the kryokonite cavities became more and more troublesome. This was made more unpleasant by rain, which began to fall on the after- everybody fancied he could distinguish mountains far away to the east. They appeared to remain perfectly stationary as the clouds drifted past them, — a sure sign, we thought, of its not being a mass of clouds. They were scanned with telescopes, drawn, discussed, and at last saluted with a ringing cheer; but we soon came to the conclusion that they were unfortunately no mountains, but merely the dark reflection of some lakes farther to the east in the ice-desert.

In my report of the expedition of 1870, I drew attention to a clayey mud which is found in circular cavities, from one to three feet in depth, on the surface of the inland ice, not only near the shore, but even as far inland as we reached on that occasion.

My companion on that occasion, Professor Berggren, discovered that this substance formed the substratum of a peculiar ice-flora, consisting of a quantity of different microscopical plants (algae), of which some are even distributed beyond the clay on the ice itself, and which, in spite of their insignificance, play, beyond doubt, a very important part in nature's economy, from the fact that their dark color far more readily absorbs the sun's heat than the bluish-white ice, and thereby they contribute to the destruction of the ice-sheet, and prevent its extension. Undoubtedly we have in no small degree to thank these organisms for the melting-away of the layer of ice which once covered the Scandinavian peninsula. I examined the appearance of this substance in its relation to geology, and demonstrated, —

1. That it cannot have been washed down from the mountain ridges at the sides of the glaciers; as it was found evenly distributed at a far higher elevation than that of the ridges on the border of the glaciers, as well as in equal quantity on the top of the ice-knolls as on their sides or in the hollows between them.

2. That neither had it been distributed over the surface of the ice by running water, nor been pressed up from the hypothetical bottom 'ground' moraine.

3. That the clay must therefore be a sediment from the air, the chief constituent of which is probably terrestrial dust spread by the wind over the surface of the ice.

4. That cosmic elements exist in this substance, as it contained molecules of metallic iron which could be drawn out by the magnet, and which, under the blowpipe, gave a reaction of cobalt and nickel.

Under these circumstances, the remarkable dust which I have named 'kryokonite,' i.e., ice-dust, obtained a great scientific interest; particularly as the cosmic element, viz., the matter deposited from space, was very considerable. Even later students who have visited the inland ice have observed this dust, but in places surrounded by mountains, from which it might with more probability have been washed down. They have, therefore, and without having examined Professor Berggren's and my own researches of 1870, paid little attention to the same; while the samples brought home by Dr. N. O. Holst from South Greenland in 1880 were not very extensive.

But now Dr. Berlin brings home from a great variety of places ice algae, which, I feel convinced, will contribute fresh materials to our knowledge of the flora of the ice and snow. For my own part, I have re-examined my first researches of the kryokonite, and they are fully corroborated. Everywhere where the snow from last winter has melted away, a fine dust, gray in color, and, when wet, black or dark brown, is distributed over the inland ice in a layer which I should estimate at from 0.1 to 1 millimetre in thickness, if it was evenly distributed over the entire surface of the ice. It appears in the same quantity in the vicinity of the ice-border surrounded by mountains as a hundred kilometres inland; but in the former locality it is mixed with a very fine sand, gray in color, which may be separated from the kryokonite. Farther inland this disappears, however, completely. Gravel or real sand I have never, in spite of searching for them, discovered in the kryokonite. The kryokonite always contains very fine granular atoms, which are attracted by the magnet, and which, as may be demonstrated by grating in an agate mortar and by analysis under the blowpipe, consist of a gray metallic element; viz., nickel iron. In general, the dust is spread equally over the entire surface of the ice. Thus it was found everywhere where the snow from the previous year had melted away; while, to judge by appearances, there seemed to be little difference between the quantity found near the coast, and in the interior. The dust does not, however, form a continuous layer of clay, but has, by the melting of the ice, collected in cavities filled with water, which are found all over the surface. These are round, sometimes semicircular, one to three feet in depth, with a diameter of from a couple of millimetres to one metre or more. At the bottom a layer of kryokonite one to four millimetres in thickness is deposited, which has often, by organisms and by the wind, been formed into little balls; and everywhere where the original surface of the ice has not been changed by water-currents, the cavities are found so close to each other that it would be very difficult to find a spot on the ice as large as the crown of a hat free from them. In the night, at a few degrees below freezing-point, new ice forms on these hollows; but they do not freeze to the bottom, even under the severest frost, and the sheet which covers them is never strong enough to support a man, more particularly if the hole is, as was the case during half our journey, covered with a few inches of newly-fallen snow.

The kryokonite cavities were perhaps more dangerous to our expedition than any thing else we were exposed to. We passed, of course, a number of crevasses without bottom as far as the eye could penetrate, and wide enough to swallow up a man; but they were 'open,' i.e., free from a cover of snow, and could with proper caution be avoided; and the danger of these could further be minimized by the sending of the two-men sledges in front, and, if one of the men fell into the crevasse, he was supported by the runners and the alpenstock, which always enabled him to get up on the ice again. But this was far from being the case with the kryokonite hollows. These lie, with a diameter just large enough to hold the foot, as close to one another as the stumps of the trees in a felled forest; and it was therefore impossible not to stumble into them at every moment, which was the more annoying as it happened just when the foot was stretched for a step forward, and the traveller was precipitated to the ground with his foot fastened in a hole three feet in depth. The worst part of our journey was four days outward and three days of the return; and it is not too much to say that each one of us, during these seven days, fell a hundred times into these cavities, viz., for all of us, seven thousand times. I am only surprised that no bones were broken, — an accident which would not only have brought my exploration to an abrupt close, but might have had the most disastrous consequences, as it would have been utterly impossible to have carried a man in that state back to the coast. One advantage the kryokonite cavities had, however; viz., of offering us the purest drinking-water imaginable, of which we fully availed ourselves without the least bad consequences, in spite of our perspiring state.

On July 16 we covered thirteen, on the 17th eighteen and a half, and on the 18th seventeen and a half, kilometres. The country, or more correctly the ice, now gradually rose from 965 to 1,213 metres. The distances enumerated show that the ice became more smooth; but the road was still impeded by the kryokonite cavities, whereas the rivers, which even here were rich in water, became shallower but stronger, thus easier of crossing. Our road was, besides, often cut off by immense snow-covered crevasses, which, however, did not cause much trouble.

On the night of the 18th, when arrived at camp no. 14, the Lapp Anders came to me and asked if he might be permitted to 'have a run;' viz., to make a reconnaissance on 'skidor,'[1] to see if there was no land to the east. This granted, he started off without awaiting supper. He came back after six hours' absence, and reported that he had reached twenty-seven kilometres farther east; that the ice became smoother, but was still rising; but there was no sign of land. If his statement was true, he had, after a laborious day's journey, in six hours covered about sixty kilometres! At first I considered his estimate exaggerated, but it proved to be perfectly correct. It took us, thus, two whole days to reach as far as he had got, as shown by the track in the snow. I particularly mention this occurrence in order to show that the Lapps really did cover the estimated distance of their journey eastward, of which more below.

During these days we passed several lakes, some of which had the appearance of not flowing away in the winter, as we found here large ice-blocks several feet in diameter, screwed up on the shore; which circumstance I could only explain by assuming that a large quantity of water still remained here when the pools about became covered with new ice. The lakes are mostly circular, and their shores formed a snow 'bog' which was almost impassable with the heavy sledges.

On July 19 we covered seventeen and a half, on the 20th sixteen and a half, on the 21st seven, and on the 22d seven and a half, kilometres (15th to 18th camp). The ice rose between them from 1,213 to 1,492 metres. The distances enumerated fully show the nature of the ice. It was at first excellent, particularly in the morning, when the new snow was covered with a layer of hard ice; but on the latter days we had great difficulty in proceeding, as a sleet fell with a south-east wind in the night, between the 20th and the 21st. The new snow, as well as that lying from the previous year, became a perfect snow-bog, in which the sledges constantly stuck, so that it required at times four men to get them out. We all got wet, and had great difficulty in finding a spot on the ice dry enough to pitch the tent. On the 22d we had to pitch it in the wet snow, where the feet immediately became saturated on putting them outside the India-rubber mattresses. A little later on in the year, when the surface of the snow is again covered with ice, or earlier, before the thaw sets in, the surface would no doubt be excellent to journey on.

When we, therefore, on July 21, were compelled to pitch the tent in wet snow, as no dry spot could be discovered, and it was impossible to drag the sledges farther, I sent the Lapp, Lars Tuorda, forward on 'skidor' to find a dry road. He came back, and stated that the ice everywhere was covered with water and snow. For the first time in his life he was at a loss what to suggest. It being utterly impossible to get the sledges farther, I had no choice. I decided to turn back.

I wished, however, to let the Lapps go forward some distance to the east to see the country as far as possible. At first I considered it advisable to let their journey only last twenty-four hours; but as both Anders and Lars insisted that they were most eager to find the 'Promised Land,' and said they could do nothing towards discovering it in that short period, I granted them leave to run eastwards for four days and nights, and then return.

On leaving, I gave them the following written orders: —

"Instructions for Lars and Anders's 'skid' run on the inland ice of Greenland; viz., —

"Lars and Anders have orders to proceed on skidor eastwards, but are allowed to alter the course, if they may deem it advisable, to north or south.

"At the end of every third mile the barometer shall be read, and the direction run noted.

"The absence is to be four days, but we will wait for six days. After that, viz., on the morning of July 28, we return. If not returned, we leave behind, in a sledge, provisions, brandy, mattresses, etc.

"Lars is warned not to be too bold. Should land be reached, you are to collect as much as you may gather of blossoms and grass; if possible, several kinds (specimens) of each.

"Given on the inland ice in Greenland, July 21, 1883. A. E. NORDENSKIÖLD."

They were allowed to select what provisions, etc., they desired, and were furnished with two compasses, aneroid barometers, and a watch.

At 2.30 A.M. on July 22 they started. The days we waited for them were generally spent in the tent, as water surrounded us everywhere. The sky was covered with a thin veil of clouds, through which the sun shone warmly, at times even scorchingly. From time to time this veil of clouds, or haze, descended to the surface of the ice, and hid the view over the expanse; but it was, remarkably enough, not wet, but *dry*, — yes, so dry that our wet clothes absolutely dried in it. We have therefore, I consider, witnessed a

[1] The Swedish 'skidor' and Norwegian 'ski' are long strips of pine wood, slightly bent at the top, polished, and as elastic as if they were of the finest steel, with a strap for the feet in the centre, on which the Lapps and Scandinavians run on the snow with remarkable agility at a tremendous pace.

phenomenon on the inland ice of Greenland which is related to the 'sun-smoke' phenomenon of Scandinavia; viz., what Arago has described under the name 'brouillard sec.'

On the 24th, after an absence of fifty-seven hours, the Lapps returned. It was the want of drinking-water and fuel which compelled them to return. The surface had been excellent for their journey, and they had covered a distance out and back of two hundred and thirty kilometres, — an estimate which I consider perfectly reliable. During the march forward the barometer was read every third hour. It gave the point of return a height of two thousand metres.[1]

As to the run, Lars rendered the following report. When they had reached thirty miles from the camp, no more water could be found. Farther on, the ice became perfectly smooth. The thermometer registered −5° C. It was very easy to proceed on the 'skidor.' At the point of return the snow was level, and packed by the wind. There was no trace of land. They only saw before them a smooth ice, covered by fine and hard snow. The composition of the surface was this: first four feet of loose snow, then granular ice, and at last an open space large enough to hold an outstretched hand. It was surrounded by angular bits of ice (crystals). The inland ice was formed in terraces, thus: first a hill, then a level, again another hill; and so on. The Lapps had slept for four hours, from twelve midnight on July 23, in a hollow dug in the snow while a terrific storm blew. They had till then been awake for fifty-three hours. On the first day there was no wind; but next day it came from the south, and lasted thus until twenty-four miles on the return-journey, when it changed to west. On the return-journey, when forty miles from our camp, two ravens were seen. They came from the north, and returned in the same direction. The Lapps had for a moment lost the track of the 'skidor' in the snow. The ravens flew at first, they found, parallel with the track, and then turned to the north.

On July 25 we began the return-journey. It was high time, as the weather now became very bad; and it was with great difficulty we proceeded in the hazy air between the number of crevasses. The cold, after the sun sank below the horizon at night, also became very great; and on the morning of July 27 the glass fell to −11° C.

As to the return-journey, I may be very brief. The rivers now impeded us but little, as they were to a great extent dried up. The ice-knolls had decreased considerably in size too, and lay more apart; but the glacial crevasses had greatly expanded, and were more dangerous, being covered with snow. Even the cavities and the glacial wells, of which many undoubtedly leave a veritable testimony of their existence behind them in the shape of corresponding hollows in the rock beneath, had expanded, and increased in number. On a few occasions on the return-journey we saw flocks of birds, most probably water-fowl, which were returning from the north.

[1] I have as yet been unable to verify the barometer calculations, and the figures stated here may suffer some modification.

On July 31 we again sighted land, which was reached on the afternoon of Aug. 4, and proceeded to Sophia harbor, where Eskimos were, as arranged, waiting for us. For convenience' sake I now divided our party into two, one of which sailed in the lifeboat of the Sophia to Egedesminde, where the steamer was to take us on board; and the other, in which was myself, marched to that place across the low but broad promontory which separates Tessiusarsoak and South-East Bay, and then in two Eskimo 'kone' boats to Ikamiut and Egedesminde.

On Aug. 16 the Sophia arrived from the north, embarked us, and made for Ivigtut, where we arrived on the 19th.

Of the expedition carried out under Dr. Nathorst during my absence, he will himself make a report,[1] and I have no doubt that the results of the same will prove very important. Particularly will the very rich collections of fossil plants, which he has made with the greatest regard to the geological condition of the strata, be of great value to science, as they will furnish us with many new materials, and detailed illustrations of the flora of the far north during the epoch when forests of fig-trees, cycadi, gingko, magnolia, and tulip trees covered these regions. Dr. Forsstrand and Herr Kolthoff's collections and studies of the fauna of Greenland will also contribute to extend our knowledge of the naturalistic conditions of the arctic regions; while the careful researches made by Herr Hamberg, of the saltness, composition, and temperature of the sea, will, I am sure, greatly benefit hydrography. His researches have been effected in Davis Strait and Baffin's Bay too, the hydrographical conditions of which are but little known.

With regard to the results of my exploration of the inland ice, I may be permitted to say a few words. That we found no ice-free land in the interior, or that it does not exist between 68° and 69° latitude in Greenland, is due directly to the orographical conditions which exist in this part of the country, as referred to in my programme of the expedition.[2] The land has here the form of a round loaf of bread, with sides which gradually and symmetrically slope down to the sea; i.e., exactly the shape which I then pointed out was a necessary condition if the entire country should be covered with a continuous sheet of ice.

But, thanks to the Lapps, my expedition is the first which has penetrated into the very heart of the enormous Greenland continent, and which has thus solved a problem of the greatest geographical and scientific importance. It is the first exploration of the hitherto unknown interior of Greenland, the only continent in the world into which man had not penetrated.

A new means of locomotion, the 'skidor,' seems also to have been acquired for the arctic explorer of the future, which may greatly assist him in his work, and enable him to reach places hitherto deemed impossible of approach, but of the use of which the Lapp seems to possess, so to speak, the monopoly.

A. E. NORDENSKIÖLD.

[1] *Nature*, vol. xxviii. p. 541.
[2] *Ibid.*, p. 37.

LETTERS TO THE EDITOR.

Osteology of the cormorant.

I WOULD make a couple of corrections to the article on the osteology of the cormorant in SCIENCE for Nov. 16.

First, the occipital style is figured as pointing upwards and backwards, and is spoken of as figured *in situ* for the first time. Having made several dissections of cormorants in past years, I would suggest that the bone is the ossified tendon of some of the extensor muscles of the neck, and that it points backwards, and, if any thing, downwards, as figured by Selenka (Bronn's Thierreichs, Vögel, figs. 5, 6, pl. viii.). As drawn in SCIENCE, it would project through the skin of the nape.

Secondly, the patella is spoken of as very large and as throwing "some light on such birds as Colymbus and Podiceps, where this bone becomes anchylosed with the tibia in the adult;" and Professor Owen is referred to as authorizing this statement. Now, Professor Owen describes the patella as 'co-existing with the long rotular process in the loon' (Comp. anat., ii. 83), and figures it as distinct from the process in fig. 34, *l*. In fact, the rotular process was regarded as the anchylosed patella until the time of Nitzsch. This celebrated ornithologist pointed out the co-existence of an enormous patella and rotular process in Podiceps, and showed the true nature of the process ('Osteogr. beitr. zur nat. der vögel.' Leipzig, 1811, pp. 98–101, pl. ii., figs. 13, 14). In fact, the rotular process of the divers is exactly the same in nature as in other birds, differs only in size, and in no wise represents the *co-existing* patella. In position and function the rotular process resembles the olecranon.

J. AMORY JEFFRIES.

Sense of direction.

Professor Newcomb's paper in SCIENCE of Oct. 26 opens an exceedingly interesting, if not a very important subject. It has exacted of me a good deal of thought, and this capricious sense has been a source of no little annoyance. I should like to give a little of my experience. With me the co-ordinates almost invariably revolve 180°. When a boy, I studied geography, and when at recitation sat with my face to the north. I thus had the whole world mapped out in my mind to correspond with my proper sense of the directions. Soon after this, my father moved to a new home; and there I found, to my great annoyance, that my co-ordinates had revolved 180°. My geography was in the greatest confusion. When I began to travel, I found that the co-ordinates would change in the most unexpected manner, first one way, and then the other. I could not trust my sense of direction.

When I came to Lebanon, I found myself with my original boyhood co-ordinates. I graduated, and went back to Arkansas. Upon my return to Lebanon a few months afterwards, the directions had revolved 180°, and I found myself practically in a new town. I had to learn it all over again; and to-day, if I desire to point to the north, my hand instinctively moves towards the south. In travelling I have found it useful to trust as little as possible to the sense, and be guided by the map. In an extended tour through Europe, I was in the habit of preparing myself, before entering each city, by a careful study of its map, — noting the position of the railway-station, direction of the streets etc. In this manner I was enabled to control the sense of direction. In only one or two instances did I fail to keep the directions right.

I make two practical suggestions: —

1. Students in geography should always sit with their faces to the north.
2. Travellers should prepare themselves, before entering a new place, by a previous subjective arrangement of the directions they are to find there.

J. I. D. HINDS.

Cumberland university, Lebanon, Tenn.

Synchronism of geological formations.

In SCIENCE of Nov. 16, weekly summary, under above heading, Professor A. Heilprin is reported as having called attention to two conclusions of Huxley's on this subject, and to have maintained, that while the first-mentioned conclusion could be logically disproved, and the second derived no confirmation from the supposed facts, the opinion of the older geologists, that geological contemporaneity is equivalent to chronological synchronism, was therefore probably correct.

Professor Huxley, in his presidential address to the Geological society for 1862, supported the conclusions called in question by reasoning, which, so far as I know, has yet to be shown to be illogical. Neither am I aware, that, during the twenty-one years which have since elapsed, geological or paleontological research has tended otherwise than to maintain the logical basis on which he then rested.

If Professor Heilprin will but do what he is reported to claim can be done, he will earn the gratitude of all other geological students by helping to settle what has proved a vexatious question for the past half-century.

E. NUGENT.

Pottstown, Nov. 22, 1883.

From superstition to humbug.

Your editorial in the Nov. 16 issue of SCIENCE might very appropriately have contained an account of the 'magnetic springs' which underlie this portion of the state of Ohio. From my residence three of these springs may be seen, at one of which a large bath-house has already been erected, where, during the present season, an average of forty patients daily tested the curative effects of the waters. These springs are found along the bank of a small creek and at the base of a valley, perhaps twenty-five feet in depth. The water, which contains less than a sixth of one per cent of iron, is brought to the surface of the ground through an *iron* gas-pipe, and "becomes so highly charged with magnetism that it will impart its properties to a knife-blade." The village of Magnetic Springs, a few miles distant, has several large hotels, all of which are so crowded with guests, that rooms must be engaged weeks in advance. Change of residence, rest, and good nursing have together effected a number of cures, all of which, of course, are ascribed to the magnetic properties of the water. Many of the guests return to their home as disappointed as the little girl, who, after drinking a glass of the water, said, 'I do not feel one particle magnified, and I think these springs are a humbug.'

E. T. NELSON.

Delaware, O., Nov. 22, 1883.

Primitive visual organs.

The notice of Dr. Sharp's communication made before the Academy of natural sciences of Philadelphia, in No. 42 of SCIENCE [397], on the habits and on the peculiar visual organs of Solen ensis and S. vagina, between and at the base of the short tentacular processes along the external edge of the distal part of the siphons of these animals, reminds me that I have observed similar habits in other marine animals, and that possibly we may infer that similar visual cells exist in these cases. I now call to mind the cases of Ostrea and Serpula. When the former has its purplish tentacles extruded from between its valves, and the latter its crown of cirri extended from its tube, if the hand is made to move rapidly over the water in the aquarium in a strong light, so as to cast a shadow upon these organs, both these animals appear to be sensitive to the movement, and independent of any jars or vibrations. The oyster, under these circumstances, at once retracts its sensitive mantle-border; the worms, their cirri.

Upon examining the end of the siphon of Mya arenaria, lines of pigment are found about the bases of both the inner and outer circlets of tentacles, and the upper end of the siphon is pigmented for about an inch, both inside and outside. On the outside, however, there are scattered low, minute, pigmented papillae just under the epidermis and in the pigmented layer or true skin covering the siphon. The questions now arise, What is the nature of these organs? and do not the habits of Ostrea, as above described, justify us in expecting to find rudimentary end-organs on the mantles and siphons of mollusks, answering the purpose of eyes, as appears to be the case in the instance of Solen? Mya, like Solen, in life has normally the end only of the siphon exposed: and visual powers, developed to a certain degree, would therefore be useful to the animal; for, when the siphon is extended above the level of the sand, there are several fishes with mouths and teeth well suited to nip it off, and which would doubtless actually take advantage of the helpless clam, if it could not appreciate their approach.

I find fishes much more sensitive to sudden vibrations established in the water in which they live than to shrill or grave sounds made in the surrounding air near by. This may be due to special powers of perception which they may possess on account of the development of the singular end-organs of the lateral line.

The study of dermal, terminal nerve-endings, modified as more or less specialized sensory apparatuses throughout the different groups of the animal kingdom, is bound to yield many important results in the near future, in addition to what is already known; and the writer is glad that the matter has been taken up by such competent hands. John A. Ryder.

Nov. 27, 1883.

Probable occurrence of the Taconian system in Cuba.

Last year, while making two excursions across the mountains of eastern Cuba, between Baracoa and the southern coast, I had an opportunity to make some observations on the geological structure of these mountains. The rocks composing this end of Cuba fall naturally into three distinct groups, as follows: 1. Ancient, and for the most part coarsely crystalline, basic eruptive rocks; 2. Older stratified rocks, slates, schists, and limestones; 3. The post-tertiary limestones or elevated coral-reefs.

The eruptive rocks form the main mass of the mountains at most points. They appear on the shore in some places, and seem to be almost the only rocks found at greater distances than five or ten miles from the coast. The older stratified rocks occur principally in two irregular belts running parallel with the coasts, and lying one on either side of the great eruptive belt: hence they are found mainly on the flanks of the mountains. The stratified rocks, especially along their contact with the eruptives, are penetrated by numerous irregular masses and dikes of the latter. But that they are all older than all the eruptives is improbable, since the eruptives are themselves evidently of several distinct ages.

So far as I have observed, the stratified rocks are all alike unfossiliferous; and in consequence the precise determination of their stratigraphic positions is a difficult problem. I am satisfied, however, that some of them are widely separated in time. The newer beds, consisting chiefly of fissile slates, soft sandstones, and impure earthy limestones, are probably equivalent to the secondary and tertiary strata of San Domingo and Jamaica. These uncrystalline sediments occur chiefly on the northern slope of the mountains, and, although much disturbed and undulating, rarely exhibit high dips.

But on the south side of the dividing-ridge, or summit, I crossed a belt six to eight miles wide, reaching almost to the coast, of highly inclined crystalline schists. The stratification is usually distinct, the strike being parallel with the coast, or east-west. The schists are generally greenish, and are both hydromicaceous and chloritic. Associated with the schists are several immense beds of white crystalline limestone. The limestone undoubtedly belongs to the same series as the schists, and is often micaceous.

These rocks bear a strong resemblance to the Taconian system of western New England, and are essentially identical with the great series of semi-crystalline schists and limestones of Trinidad and the Spanish Main which I have elsewhere correlated with the Taconian.

The published reports on the geology of San Domingo and Jamaica show that the geologic structure of those islands is essentially similar to that of eastern Cuba. In each case there is a prominent axis of old eruptive rocks, flanked on either side by schists, slates, limestones, and other sedimentary formations, and by elevated coral-reefs. In San Domingo and Jamaica the eruptives are not wholly basic, but much granite occurs; and the metamorphic schists, which appear to be similar to those of Cuba, have been generally confounded with the cretaceous beds. I predict, however, that more careful study will show that they are distinct and vastly older, and that the Greater Antilles are similar in composition and structure to the southern coast of the Caribbean Sea, including the Spanish Main and Trinidad, except that the coral-reefs and the eruptive rocks are wanting in the latter region. We owe the coral-reefs largely to the great vertical movements of the Greater Antilles in recent times; and the eruptive rocks are but a continuation westward, and the older and more eroded portion, of the great Caribbee belt of volcanic rocks which begins a hundred miles north of Trinidad, and ends in Cuba, being about fifteen hundred miles long.

W. O. Crosby.

THE RESTORATION OF ANCIENT TEMPLES.

The Parthenon: an essay on the mode by which light was introduced into Greek and Roman temples. By James Fergusson, C.I.E., D.C.L., LL.D., etc. London, *Murray*, 1883. 8+135 p., 60 illustr., 4 pl. 4°.

Only a small portion of this book is devoted to the wonderful edifice from which it is named. It is in the main a reiteration of peculiar views concerning the lighting of ancient temples, — an amplification of theories advocated thirty-four years ago by Mr. Fergusson, in his 'True principles of beauty in art.' In a preface to the present volume, the author states his conviction that it is certain to prove offensive to specialists 'from the novelty of the views advanced;' but as these views are almost exactly those adopted in his earlier publication, and as this application of a clere-story to ancient temples can hardly be called original, — it having been suggested by Boetticher in 1847, two years before its first mention by Mr. Fergusson, — it would seem more natural to seek for some other explanation for the discontent of the critics.

It is certainly true, that more has been written, and more angry controversies have arisen, regarding the hypaethron, than with reference to any other feature, either constructive or artistic, in the temples of the Greeks; and after careful study the conviction forces itself upon the reluctant mind, that this last contribution, surpassing in extent and elaboration all others, does little toward the confirmation of that hypothesis in any of its varieties.

Mr. Fergusson adopts for the Parthenon, the temple of Zeus and that of Hera at Olympia, the temples of Aegina, Paestum, Selinous, — in short, for all regular Greek peristyles, — a clere-story sunk by two long openings in the roof at either side of the ridge, which remains unbroken over the central aisle of the naos. The height between the entablature of the upper order of interior columns and the inclined lines of the roof is that of his vertical windows. The drainage from this imperfect covering is effected by perforating the lateral walls of the cella with gutters, leading the rain-water into the pteroma, in which ceiled and protected colonnade such dripping must have been particularly undesirable. Contrary to the fundamental separation of roof and ceiling universally carried out in Greek architecture, he leaves the central aisle open to the inclined roof-surface, like the Bavarian Walhalla, and defends this feature with the surprising statement that flat ceilings, in either wood or plaster, were unknown in classical times. The argument adduced to prove this inclination of the ceiling, visible from within, is found by Mr. Fergusson in the well-known complaint of Strabo (viii. 3, 30, p. 353), — that the statue of Zeus at Olympia was so large, that, if the seated deity should arise, the roof of the building would be carried away. This passage is certainly not "the only hint in any ancient author as to how the roofs of Greek temples were constructed," and, what is worse, its application to the point in question is dependent upon a mistranslation. The words of Strabo, 'almost touching the ceiling with *the top of its head*,' are wrongly rendered by Mr. Fergusson, 'nearly touched *the summit of the roof*.' This misleading version is twice given in the present volume (pp. 2 and 111), and from it the non-horizontal form of the ceiling is directly deduced. It seems high time that this blunder, repeated by so many writers since its first commission by Quatremère de Quincy, should at last be eliminated from discussions of the subject.

As it would naturally have been impossible to surmount with a clere-story those smaller peripteral temples which were without columns in the naos, Mr. Fergusson is obliged to assume, against all evidence, that interior pillars or pilasters did originally exist, and that, while the Christian reconstruction of the Theseion obliterated the traces of these in that building, a figured mosaic pavement in the remarkably similar temple of Assos should be taken to indicate the position of such supports. The last example is certainly not favorable to the theory; for the bedding of the pavement in question is distinctly shown, by plan and text of the first report on the investigations at Assos,[1] to have extended to the very edge of the lateral walls, thus precluding the possibility of any columns or piers within the narrow hall.

The omission of galleries from interiors, which were provided with a double range of columns standing at some distance from the wall, is even less excusable. The assertion (pp. 8 and 73) that there were no galleries in the temple of Aegina is unwarranted. The only reason advanced for this, that the space between the shafts and the wall was only about one metre in width, is of no weight. To suppose that one order of columns was balanced upon another, with an intermediate entablature not tied to the wall by a floor, is unworthy our conception of the constructive wisdom displayed in Greek architecture. These galleries, known from literary sources to have existed in many temples, were actually found and measured at Paestum; and yet Mr. Fergusson omits them entirely from his section of that monument, without a word of justification (fig. 41). The notched architrave from the same site, in which he sees 'the most direct proof of the theory,' 'final in its correctness,' has really no bearing upon the question, being simply an example of the commonest method of construction, when adjoining horizontal ceilings were employed on different levels. This appears constantly in every kind of Greek buildings.

In one instance, however, the author must

[1] Rep. arch. Inst. Amer.

be admitted to have proved his case. The plan and interior arrangement of the temple of Bassae — which is in so many ways exceptional among buildings of its class — certainly point to some system of lighting by vertical windows above the interior ranges of pilasters. The curious position of these buttresses, which are awkwardly spaced so as to stand in the axes of the intercolumniations of the side colonnade, and especially the discovery of perforated tiles on the site, make it more than probable that this remarkably archaistic temple displays an intentional reversion to the manner of lighting the primitive, non-peripteral cella through open metopes. It is to be observed that the statue of the deity was not placed in the space thus lighted, which seems to have been considered as a sort of inner vestibule before the Holy of holies, — a hall decorated, like the exterior of the Parthenon, with a carved zophoros, intended to be seen by the general public. Mr. Fergusson is probably at fault in supposing the image at Bassae to have been a mere *simulacrum*, which had become sacred among the rude inhabitants of the mountain from some accidental cause. He gives no reason for such a belief, and of no temple of antiquity is the story of the dedication so well known. The deliverance of the Arcadians by Apollo Epikourios, from a prevalent pestilence toward the end of the fifth century, does not admit the assumption of a rude symbol, or even of a xoanon, within his fane.

The explanation of the roof-opening of the little cella upon Mount Ocha is good, as is also the concise treatment of the corrupt text of Vitruvius. The importance of both these points has certainly been greatly overrated by previous writers upon the subject. Mr. Fergusson advocates the change of *octastylos* to *decastylos*, and *et* to *est*, in the confused description of the Roman builder; and this appears plausible in view of the acknowledged corruption of the manuscripts, and the fact that the temple of Olympian Zeus at Athens, thus alone referred to, was the only building in Europe possessing all the peculiarities described. Having been without a roof at the time Vitruvius wrote, it certainly was *sub divo* and *sine tecto*, as he says. Mr. Fergusson's restoration of this temple is ingenious; but as it is not known that the structure was ever completed at all, and as even its plan is not yet ascertained, the attempt to delineate its roof is hardly of greater value than that dissertation 'on the use of the particle δέ in the lost plays of Menander,' which a German scholar is wickedly reported to have written.

And what are we to think of the disquisition on the Chaitya temple of Karlé, dragged in to lend weight to this restoration? That excavation in the native rock is lighted by a great window at the front, as it of course only can be: and yet in this feature Mr. Fergusson sees the direct influence of Greek and Roman architecture, felt after the incursion of Alexander into India, and the establishment of the Bactrian kingdom; making the system of illumination employed for the cave an imitation of that in the temple of Zeus at Athens by the argument that the appearance of light-openings on one side only must have been foreign to the wooden structures from which the Chaitya caves were in detail more or less imitated. Surely insistence upon precedent could be carried no farther.

The author's restorations of other temples are interesting, but hardly less improbable; the complicated makeshifts to which he is driven, by his various systems of windows in light-shafts, being too remote from the simple and straightforward methods of ancient building to please our imagination, or satisfy our practical sense of constructive fitness. A detailed consideration of all the temples treated of would here lead to undue length.

The account of the derivation and timbered prototype of the Doric style is inadequate; and the attempt to rehabilitate Falkener's proto-Doric capital unreasonable, after the well-known proof by Bergau and Erbkam of its wrong combination out of fragments of Egyptian bases. Incorrect, also, is the reiterated statement, that no Doric temples were built after the age of Alexander the Great. In certain parts of the Hellenic world other styles were but exceptionally employed, even in the latest epoch; as we know, for instance, from the ruins of Pergamon, where there is a complete Doric peripteros (that of Athena Polias), which certainly was constructed under the dynasty of the Attalidae. The comparison of the development of temple-architecture among the Greeks with Catholic church-building during the middle ages and during the reign of Queen Anne is misleading. Style among the ancients depended rather on geographical, or, to speak more correctly, on ethnographical, distribution than on passing fashions.

The description of the Parthenon is as thorough as any review antedating the recent investigations of Doerpfeld, which may not have been available at the time of writing. A model of the building, constructed by Mr. Fergusson on a generous scale, one-fortieth of real size, must be extremely interesting. Too much cannot be said in recognition of this interest in a branch of science not over-popular in these days, which has led the author to an expense of time and money hardly likely to be appreciated. Still, it is to be regretted that the chief attention devoted to this reproduction was evidently directed to an exemplification of an improbable method of lighting. A second gallery is added to the temple, the trenches sunk deeply in the roof being made accessible by stairs; and these *piombi* Mr. Fergusson sets apart for the females of the Athenian congregation, who must have been as uncomfortable there as the most confirmed misogynist of antiquity could have desired. The staircases, by the way, present in the section (pl. 3) a curiously impossible arrangement, approaching from either side as they ascend, so as to intersect at the level of the gallery, and leave no landing-place, — not a good instance of that application of common sense to the study of Greek architecture which Mr. Fergusson so warmly advocates. It has, moreover, been ascertained that the stairs in the Parthenon were situated where they might naturally be expected, — next to the entrance-door, not at the farther end of the naos.

A part of the book sure to be read with great satisfaction by students of archeology is the arraignment of Mr. Wood, the explorer of Ephesos, whose inadequate publications, and selfish hiding-away of the results of his richly endowed work, deserve all the asperity with which Mr. Fergusson treats them (p. 32).

The printing is careful. We notice few minor errors. Lagardette's folio is dated Paris, 1879, instead of 'seventh year of the republic (1799);' while 'M.' Boetticher's essay, published at Potsdam in 1847, is said to be without date.

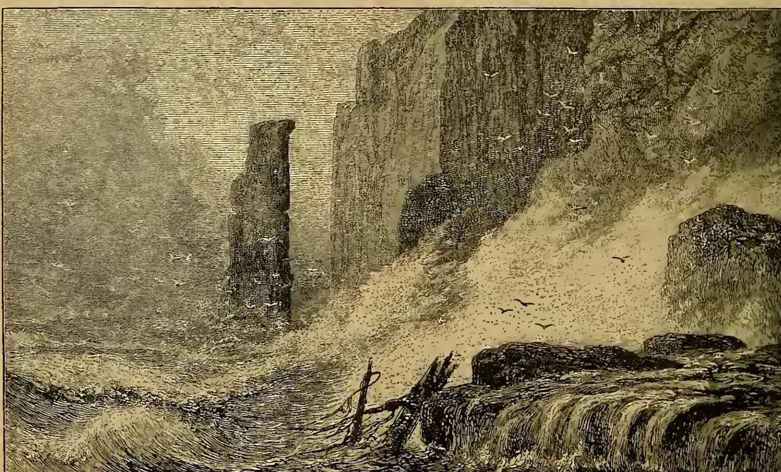
SCALLOWAY FROM THE NORTH-EAST.

THE ORKNEYS AND SHETLAND.

The Orkneys and Shetland; their past and present state. By John R. Tudor. London, *Stanford*, 1883. 29+703 p., illustr. 8°.

Mr. Tudor has collected and revised a series of letters published under the *nom de plume* of 'Old Wick,' in *The field*, the English sporting-journal, from 1878 to 1880, on the Orkneys and Shetland, and, with contributions from several scientific friends, has prepared a very entertaining book on these out-of-the-way islands. The general reader will find in it an interesting historical essay, embracing the period from Norse occupation to modern times, followed by local descriptions and numerous maps, that may well serve as a visitor's guide. Primitive old-fashioned ways have endured on these remote islands till recent times, and furnish many anecdotes to enliven the descriptive pages. The more scientific student, with a liking for botany, geology, mineralogy, or archeology, will meet with much worthy of his attention.

The two geological chapters, prepared by Messrs. Peach and Horne from their papers published in the *Quarterly journal* of the geological society and elsewhere, are of chief scientific value, and are well illustrated by neatly colored maps. The southern group is shown to be almost entirely covered by the various divisions of the old red sandstone; and, indeed, this formation once extended over a great area thereabouts, now broken up into ragged islands by dislocation, erosion, and submergence, so that only the smaller part of the original deposit remains. The topographic effect of former erosion at a higher level, followed by depression, is seen in the irregular shore-line and fringe of islands shown in the view of Scalloway. In their present attitude, the islands suffer most along their western coast, where the heavy waves of the Atlantic cut them back into imposing cliffs, such as are found on the western side of Hoy. Shetland includes a considerable variety of old metamorphic rocks, and numerous intrusives and eruptives. The relations of the latter to the adjoining masses is often finely exposed in the sea cliffs, and questions of age are not left to vague inference. Dikes, necks, intrusive sheets, and overflows are all well exhibited. But the geological interest culminates in the glacial question. These northern islands give the key to the movement of the combined Norwegian and Scotch ice-sheets, and show, as was first suggested by Croll, that they joined forces in the basin of the North Sea, and together moved north-westward, out into the Atlantic. The striae are of two dates. The later ones depend on the local topography for their direction, and are referred to a 'later glaciation,' though it is not shown that a non-glacial interval separated this from the greater or primary glaciation, during which the ice moved independently of local topography, over-riding all the hills and ridges. Only these are shown on the accompanying outline, which is traced and reduced from two maps of much larger scale in the original. On the Orkneys the scratches run north-west with much regularity. Marine shells and rocks derived from eastern Scotland are found in the bowlder-clay. On Shetland the approach of the ice was from the north-east,



RORAY HEAD AND THE OLD MAN OF HOY DURING A WESTERLY GALE.

COURSE OF GLACIAL SCRATCHES.

but the motion changed to north-west about the middle line of the group. The great variety of rocks in north and south strips gives abundant opportunity for determining this motion by the direction of dispersion of the bowlders from their parent ledges. No Scottish bowlders are found here, nor do marine remains occur in the drift. Raised beaches do not appear on any of the islands. It is concluded that Scandinavian ice covered Shetland, while Scottish ice advanced over the Orkneys; the original motion of both glacial sheets being changed where they coalesced, in the shallow North Sea, and turned to the line of least resistance, — north-west to the open ocean. There they must have ended in a great ice-cliff like that discovered by Ross in the Antarctic Ocean. It may be well to refer here to Helland's study of the Faroes a few years ago, when he showed that they bear no marks of continental glaciation, the few scratches he found there depending on local form for their guidance.

Our space forbids mention of the many other interesting topics that Mr. Tudor's book discusses, although few volumes contain so many pages of entertainment to the general reader; but attention should be called to the well-considered character of the work, only seldom marred by a remnant of newspaper style. In its table of contents, illustrations, glossary, bibliography, and index, the volume is all that can be desired.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Partial differential equations. — M. Darboux considers an arbitrary partial differential equation, defining a function, z, of any number of variables. Replacing z by $z + ez'$, developing according to powers of e, and equating to zero the coefficient of e, a new equation is formed, which the author calls the auxiliary equation. The auxiliary equation defines solutions differing infinitely little from a given solution; and so it has a signification which does not depend on the choice of variables, and which will remain unchanged by any arbitrary change of the variables. The equation, being linear, is easy to deal with, and conducts to many important results which are intimately connected with the given equation. The author considers especially two geometrical problems. First: having given a surface, Σ, attempt to find all the infinitely near surfaces which will form with Σ one family of a triply orthogonal system. This problem, which has already been studied by Prof. Cayley, is equivalent to either of the following problems: 1°, To find all surfaces admitting of the same spherical representation as Σ; or, 2°, To find all the systems of circles normal to the family of surfaces of which Σ is one. It follows at once, that, if the problem of the spherical representation of Σ is solved, the solution can be at once arrived at for the inverse surfaces to Σ, or the surfaces arrived at by the transformation by reciprocal radii.

The second problem considered by M. Darboux is one famed for its extreme difficulty; viz., to find the surfaces applicable to a given surface. Denote by δx, δy, δz, the increments taken by x, y, z, in passing from a point of the given surface, Σ, to the corresponding point on an infinitely near surface: then, expressing the necessary condition to the solution of the problem, — viz., that the small arc shall not change its length, — we have —

$$dx\, d\,.\,\delta x + dy\, d\,.\,\delta y + dz\, d\,.\,\delta z = 0.$$

Replacing δx, etc., by proportional quantities, — say, x_1, y_1, z_1, — this is $dx\,dx_1 + dy\,dy_1 + dz\,dz_1 = 0$; i.e., the corresponding elements on the surfaces Σ and Σ_1 are orthogonal. M. Darboux's problem is thus conducted back to a problem solved by M. Moutard. The surfaces for which the problem can be solved are divided into certain *classes*. M. Darboux gives the expressions for the co-ordinates of a point in terms of two parameters for the surfaces of the first class. — (*Comptes rendus*, March 19.) T. C. [441

ENGINEERING.

Theory of the screw-propeller. — Mr. J. N. Warrington, of the Stevens institute of technology, discusses the theory of the screw-propeller, and the methods of designing it. He first discusses the action of the screw in the water, investigates the conditions of maximum efficiency, and obtains expressions for the efficiency in terms of the angle of the blades, and the ratios of resistance of friction to pressures exerted. He finds, as does Froude, that the angle of maximum efficiency is forty-five degrees. It is found that a small amount of slip does not necessarily give good performance, — a conclusion already proven by experience. It is found that the action of the screw, in its most efficient operation, does not involve the sternward projection of a solid stream; and hence it follows that all investigations based, as is common, on that assumption, are inaccurate. Yet it is only the water that is thrown aft that gives propelling-power, and the nearer the stream is solid, the better. He obtains the equation of the curve of the developed screw from Thurston, and expressions for the magnitudes of diameter and thrust from Seaton. The second part of the paper is devoted to the designing of the screw according to the principles deduced in the first part. The shape of a blade upon which the water shall glide without shock, and from which it shall be thrown aft with a given velocity, acquiring that velocity by a uniform acceleration, is given by its equation as deduced by Warrington. The relation between the pressure and the acceleration is ascertained; the slip is assumed, and the total resistance is given; and the required size of screw is calculated. The magnitude of the losses of energy, and the efficiency, are determined, and the process is applied to the guide-blade propeller as well as to the common screw. Two wheels are drawn, — the one a U. S. naval-department screw, the other a screw designed on Warrington's plan. — (*Journ. Frankl. inst.*, Aug.) R. H. T. [442

Light prime motors. — President D. Napoli, of La société de navigation aérienne, in a communication to the *Aéronaute*, compares the weight of steam-engines and electric motors for use in aeronautics. He finds that the weight of fuel and water demanded by a steam-engine of twenty-horse power for ten hours' work would be not far from 1,600 kilos (3,527 lbs.), while the weight of an electric motor and its supplies would be about 1,400 kilos (3,087 lbs.); giving a decided advantage to the latter aside from the weight of the engine, which may be anywhere from two hundred and fifty to four hundred per cent greater than the weight of its supplies, according to style, which M. Napoli does not prescribe. — (*Chron. ind.*, June.) R. H. T. [443

Resistance of railway-trains. — Professor Franck has written a memoir on the resistance of trains, studying the earlier experiments of Vuillemin, Guebhard and Dieudonne, and of Rockl. He obtains the formula for resistance,

$$w = m + \frac{l F v^2}{Q},$$

in which w is the resistance in kilos per ton, Q is the weight in tons, m, l, and F are the coefficients, as follows: —

For	passenger-engines . .	$m = 0.0032$
"	freight-engines . . .	$m = 0.0038$ to 0.0039
"	the cars	$m = 0.0025$
"	all cases	$l = 0.1225$
"	passenger-engines . .	$F = 7$
"	freight-engines . .	$F = 8$
"	passenger & box cars,	$F = 0.5$
"	unloaded flat cars . .	$F = 0.4$
"	loaded flat cars . . .	$F = 1.0$

The author of the paper considers that this formula, used with this assortment of constants, will allow of very exact calculation of the resistance of trains. — (*Mém. soc. ing. civ.*, June.) R. H. T. [444

Dowson's gas for heating. — In 1882 the Messrs. Crossley put in a Dowson plant for making his gas. The trial of the system gave the following results: when the gas was made from Trimsaran anthracite, a gas-engine consumed 1.5 pounds (0.68 kilogram) per hour per horse-power; when using Garnant anthracite, the consumption was 1.4 pounds (0.64 kilogram). These results were so satisfactory that the Messrs. Crossley have adopted the gas-engine throughout their works, and are using some 200-horse power. The engine above referred to was of about 30-horse power. It is found that a larger engine, 40-horse power, uses but 1.2 pounds (0.54 kilogram). The process consists in passing a current of steam and air through a mass of red-hot carbonaceous materials. Coal-gas has nearly four times the heating-power of this gas, but the cost of the Dowson gas is so much less that it compensates this great difference. It is, however, intended to compete with the gas produced from coal-oils. The author of the paper calculates that the costs of operating a steam-engine, and of working a gas-engine driven by his gas, are as three to two, the engines being of 100-horse power each. — (*Proc. inst. civ. eng.*, 1883.) R. H. T. [445

AGRICULTURE.

Reversion of superphosphates in the soil. — Farsky shows, that, when a small quantity of water acts upon a superphosphate, the monocalcic phosphate which it contains is decomposed into dicalcic phosphate and free phosphoric acid. The same process seems to take place when a superphosphate is mixed with the soil. Subsequently the free acid appears to act upon the calcium, iron, and aluminum salts of the soil, forming dicalcic phosphate and soluble acid phosphates of iron and aluminum. The latter are not stable, and soon pass into insoluble combinations (compare SCIENCE, i. 825). — (*Biedermann's centr.-blatt.*, xii. 450.) H. P. A. [446

Fineness of superphosphates. — Farsky, both in pot-experiments with buckwheat, and in field-experiments with several other crops, found that coarse superphosphate gave a greater increase than fine. Exactly the opposite result was given by Wagner's experiments, reported in SCIENCE, i. 310. — (*Biedermann's centr.-blatt.*, xii. 453.) H. P. A. [447

Experiments on the continuous growth of wheat and barley. — These experiments by Voelcker, on the plan of the well-known Rothamsted experiments of Lawes and Gilbert, are in progress at Woburn, on a light soil, and are intended to supplement those at Rothamsted, which are on a heavy clay soil. The present report gives the results of the sixth year, viz., 1882. The most interesting of the results are those obtained on four plots, two of which had received mineral manures and nitrates or ammonia salts, and two stable-manure. Each plot was halved. One half received the same fertilizers as in preceding years; while the other remained unmanured (in case of the stable-manure plots), or received the mineral fertilizers of the preceding year, but no nitrogen. The mineral fertilizers alone gave no larger crop than was obtained from plots unmanured for six years, while the other half of the same plots, which received nitrogen, gave about thrice as large a crop. The evident conclusion was, that the plots were deficient in nitrogen, and that the large amounts of nitrates or ammonia salts, which they had received in previous years, had left no available residue of nitrogen in the soil. In the case of the plots which had received stable-manure, the unmanured halves showed that a portion of the manuring of previous years was still available, though the gain thus caused was small. In all the experiments of this year, sulphate of ammonia produced better results than an equivalent quantity of nitrate of soda. — (*Journ. roy. agric. soc.*, xix. 209.) H. P. A. [448

MINERALOGY.

Cuspidine. — This comparatively new mineral has been crystallographically examined by G. von Rath. It occurs at Vesuvius in very characteristic spear-head-shaped crystals, which are not to be confounded with any other mineral. The crystals were found to be monoclinic, the apparent rhombic form being the result of twinning. The axial relation is $a:b:c = 0.7243:1:1.9342$. $\beta = 89° 22'$. The measurements were made on a single small crystal, which showed no evidence of twinning; the symbols for seventeen different forms being obtained, cleavage parallel to the base, plane of twinning the orthopinnacoid. Sections from the mineral gave the optical properties of monoclinic crystals. Material pure enough for analysis could not be obtained, as the mineral is peculiarly liable to alteration. An analysis by E. Fischer, of impure material, showed that in addition to calcium fluoride the mineral contains the silicate Ca_2SiO_4.

A very few minute crystals of a mineral resembling cuspidine were found at Vesuvius, occurring in orthorhombic prisms, very much striated, parallel to the vertical axis, and terminated by an obtuse pyramid. An approximate axial relation, $a:b:c = 0.560:1:0.417$, was obtained; but the material did not admit of further investigation. — (*Zeitschr. kryst.*, viii. 38.) S. L. P. [449

Empholite. — This new mineral has been described by L. J. Igelström as occurring at Hörrsjöberg, Wermland, Sweden, in small, well-formed crystals and fibrous aggregates. The prisms, sometimes attaining a length of six millimetres, are brilliant, and resemble diaspore in form, the prismatic angle being about 123°–130°: with cleavage parallel to the brachypinnacoid; hardness, greater than six; color, white, changing to yellow on exposure, owing to the oxidation of the iron; before the blow-pipe infusible, giving a beautiful blue color with cobalt solution, and, in the closed tube, neutral water; scarcely attacked by acids. Two analyses, after correcting for sixteen per cent of gangue, yielded —

SiO_2	Al_2O_3	MgO. CaO. FeO.	H_2O	
52.3	30.5	3.4	13.8	= 100
48.8	33.3	3.3	14.6	= 100

The mineral is a hydrous silicate of alumina, and the formula $Al_2Si_2O_7 . 3H_2O$ is proposed; but the analyses are not correct enough to lead to any definite formula. — (*Bull. soc. min.*, vi. 40.) S. L. P. [450

METEOROLOGY.

Barometric maxima and minima. — The meteorological conditions which are characteristic of regions of high and low pressure have been studied by various investigators, notably by Mohn, Clement Ley, and Loomis. The latest contribution to this subject is made by Hildebrandsson, who bases his conclusions upon observations made at Upsala and other stations in northern Europe since 1873. He discusses the angle of the wind with the barometric gradient, the wind velocity, the direction of the upper and lower clouds, the air temperature, the amount of cloudiness and rainfall, the transparency of the air and fog, — all with regard to their relations to areas of maximum and minimum pressure. The conclusions are based wholly upon tabulations of the observations, and are primarily applicable to Upsala and vicinity, but are in general similar to those obtained for other countries. — (*La distr. élém. mét. autour min. et max. bar.*) W. U. [451

ZOÖLOGY.

Animal coloring-matters. — The application of the spectroscope to the determination and discrimination of coloring-matters from living organisms has opened an interesting field of research. Dr. C. A. MacMunn gives an extensive *résumé* of previous work, and the results of his own studies in this field. His article is a valuable presentation of our knowledge of the subject; but it necessarily contains many details, and is therefore unadapted to a brief abstract. The following points deserve special notice. Haematin may be prepared by a new method: "Fresh defibrinated blood is treated with a mixture of two parts of strong sulphuric acid to thirty-five of alcohol, and thrown on a filter, more alcohol being added to help the filtration; the filtrate is diluted with water, put into a separating funnel, and shaken up with chloroform. After standing some time, the chloroform is separated off, and filtered and evaporated. . . . The residue corresponds to haematin as it is usually described." By the action of strong mineral acids on this haematin, Hoppe-Seyler's haemato-porphyrin was obtained; it is practically identical with Thudicum's cruentin. When neutral dried cruentin is boiled with equal parts of rectified spirit and acetic acid, a five-banded spectrum was obtained, similar to if not identical with that of Preyer's iron-free haematin. Bilirubin is identical with haematoidin. There are several lutein pigments; for example, that of the hen's egg is different from that of the corpus luteum of the cow. Tetronerythrin is very widely spread, occurring in 'the roses' around the eyes of certain birds, in the skin of the red mullet, and in many invertebrates; it is apparently capable of performing respiratory functions, somewhat like haemaglobin. Its presence in the crust of lobsters and crabs is noteworthy. The various classes of invertebrates are taken up in succession, the following being the principal pigments described: chlorophyll, pentacrinin, cruentin (in starfishes), echinochrome, cochineal, aphidein, bonellein, haemocyanin (in blood of Octopus), aplysiopurpurin, dermolutein, etc. Numerous spectra are reproduced in the charts. In an appended note, it is stated that chlorophyll is found in the liver of mollusks: *cf.* Royal society's proceedings, April 5, 1883. — (*Proc. Birmingham nat. hist. soc.*, iii. 351.) C. S. M. [452

Mollusks.

Abyssal mollusks. — Dr. Jeffreys continues his valuable papers on the deep-sea mollusks of the Lightning and Porcupine expeditions. The last instalment includes the Scissurellidae, Trochidae, Turbinidae, and Littorinidae, with two fine plates on which are figured twenty-one new forms. Several new genera are described. Tharsis Jeffreys has a closed umbilicus and appressed peristome, which separate it from Cyclostrema: the type is Oystele romettensis Seguenza. Ganesa is like a very minute, delicate Lunatia, with a perforate axis. Cantrainea is suggested for Turbo peloritanus Cantraine. Hela Jeffreys, beside being pre-occupied, proves to be identical with the Japanese Cithna A. Ad. Iphitus Jeffreys is a minute form, resembling Fossarus or a miniature Tectarius, with a peculiar apex and subspiral operculum. — (*Proc. zoöl. soc. Lond.*, March, 1883.) W. H. D. [453

Further researches on nudibranchs. — Bergh prints an important paper, illustrated by five beautiful anatomical plates, as a supplement to his monograph of the family of which Polycera Cuvier is the typical genus. After a number of general notes on species and genera, among which is the description of Ohola, a new genus collected by the Challenger at Arapura in the South Seas, the author considers the Dorididae in general, with their divisions and probable phylogeny. The genus Heterodoris of Verrill and Emerton is considered as probably belonging to a different family. The Dorididae are separated into two very well marked groups by the possession of a single large retractile crown of gills or of numerous nonretractile branchia, cryptobranchiata, and phanerobranchiata respectively. The latter, connected with the typical Dorididae through Staurodoris, diverge in two lines, of which the more ancient forms are Notodoris and Akiodoris. The former culminates in Plocamophorus, with Ohola as a lateral branchlet. The latter passes through Acanthodoris, Goniodoris, etc., toward Ancula and Drepania.

The phanerobranchiate, non-suctorial Dorididae form the Polyceradae (better Polyceratidae) of Bergh, and the suctorial forms his Goniodorididae. Of these groups a full discussion is made, and a synopsis of their genera and species is given. They inhabit all seas, but are largest and most beautiful in the warmer regions. — (*Verh. zool. bot. ges. Wien*, März, 1883.) W. H. D. [454

Worms.

Development of Phoronis. — A. Foettinger has published an article on this subject in Van Beneden's *Archives de biologie* (iii. 679). He found in the morula stage, that the cavity contained a few spherical or oval corpuscles, sometimes surrounded by a fine granular substance filling the whole segmentation cavity. The important question he deems to be, whether these elements, which are clearly the first rudiments of the mesoderm, are derived from the endo- or the ecto-derm. Kowalevsky is in favor of the latter view, while Metschnikoff holds to their endodermal origin. If the larvae are treated with acetic acid, and immediately examined, evidence will be afforded as to the presence of the first mesodermic elements at a time when the ovum is still segmenting; and, indeed, indications of them were seen in two cases, where the developing ova consisted of only eight blastomeres, for there is in them a central corpuscle which appears to have a mesodermal significance. The author has no distinct opinion as to the origin of this cell, but inclines to doubt the explanation given by Metschnikoff. As to the still earlier stages, it is stated that the fecundated ova are developed outside the body of the parent, but that they remain attached to the branchiae for a certain time. After the appearance of four blastomeres, two divide, and so give rise to a six-celled stage, with two large and four smaller cells. (As to the origin of the mesoderm, compare Hatschek's researches on Sipunculus, to be given shortly in SCIENCE.) — (*Journ. micr. soc. Lond.*, iii. 509.) C. S. M. [455

Nervous system of Hirudinea. — Saint-Loup finds that the arrangements of the nervous system, which were thought to be peculiar to Clepsine, are very common among the Hirudinea. Commencing with Nephelis, he saw in the transparent tissues six capsules on the ventral surface of the ventral ganglia. Similar capsules were observed in Aulastomum and Hirudo. The author detected in all Hirudineae the intermediate or unpaired nerve first described by Brandt in the medicinal leech. Saint-Loup hopes to give a general account of the morphology of the nervous system of the group. — (*Comptes rendus*, xcvi. 1321; *Journ. micr. soc. Lond.*, iii. 509.) C. S. M. [456

Insects.

Classification of the larger groups. — From a study of the relationships of the lower insects, Packard has been led to a new arrangement of all the larger groups, and proposes the following scheme, in which the names proposed for what he terms super-orders are all new: —

Super-orders.	Orders.	Sub-orders.
Euglossata . . .	Hymenoptera.	
	Lepidoptera.	
	Diptera	Diptera (genuina).
		Aphaniptera.
		Pupipara.
Elytrophora . .	Coleoptera . . .	Coleoptera (genuina).
		Strepsiptera.
Eurhynchota . .	Hemiptera . . .	Homoptera.
		Heteroptera.
		Physapoda.
		Mallophaga.
Phyloptera . .	Neuroptera . . .	Trichoptera.
		Planipennia.
	Pseudoneuroptera .	Odonata.
		Ephemerina.
		Platyptera.
	Orthoptera.	
	Dermatoptera.	
Synaptera . . .	Thysanura . . .	Cinura.
		Symphyla.
		Collembola.

A mere outline is presented in this paper, which is only an abstract of his researches, to be published in full in the forthcoming report of the U. S. entomological commission. — (*Amer. nat.*, Aug.) [457

VERTEBRATES.

The function of body-equilibrium. — The central gray substance of the third ventricle, according to Bechterew's experiments, given in this paper, forms an organ of equilibrium in the same sense as the semicircular canals and the olivary bodies. His investigations were made chiefly upon the dog; although confirmatory experiments upon other animals, birds, and frogs, are given. The method of operating was to trephine a hole through the sphenoid bone at the sella turcica; and then, thrusting a small knife through the hypophysis into the third ventricle, a section could be made of the gray matter in any desired direction. Injury of any portion of the gray substance of the third ventricle was always followed by disturbances of equilibrium, similar, in a general way, to those caused by section of the semicircular canals. The author points out that the disturbances of equilibrium which have been noticed by other observers, after sections made in this region, but which were attributed either to the corpora striata or corpora thalami, were most probably caused by injury to the walls of the third ventricle. To explain how it is that the gray matter of the ventricle is affected by changes in equilibrium, he supposes that the cerebro-spinal liquid, which in this portion of the ventricle lies almost in a closed sac, assumes a rôle similar to that played by the endolymph of the semicircular canals. Changes in position of the body cause changes in pressure of the liquid upon the walls of the ventricle, giving rise to stimuli which act reflexly on the co-ordinating centres in the cerebellum. The preservation of body-equilibrium is brought about, according to Bechterew, by the action of three peripheral equilibrium organs; viz., the semicircular canals, the gray matter of the third ventricle, and the olivary bodies of the medulla. Disturbances of equilibrium cannot act as a stimulus to the olivary bodies by reason of any change in pressure of the cerebro-spinal liquid. The normal stimuli for this centre are found in the skin sensations, and perhaps muscle sensations, which reach the medulla from the spinal cord. Each of these three equilibrium organs, it is interesting to notice, is not only connected with the cerebellum, through which it acts on the muscles, but each is closely related also to one of the higher sense-organs, — the olivary bodies, to the skin; the semicircular canals, to the ear; and the gray matter of the third ventricle, as is shown in detail in the paper, to the eye. The intimate connection existing between the organs of sight and equilibrium is known to all; and this connection depends not so much on the visual sensations as on the position of the eyeballs. Injury to the centre in the third ventricle was always followed by marked changes in the direction of the axes of the eyeballs; and the author advances an ingenious theory to show that any change in the position of the eyeballs will act as a mechanical stimulus to this centre. Taken in conjunction with previous work by the same author, this paper makes an important addition to our knowledge of the much discussed question of body-equilibrium. — (*Pflüger's archiv*, xxxi. 479.) W. H. H. [458

Birds.

Sternum of Notornis. — In this paper Prof. Owen replies to a stricture on his plate of this bone, and makes many valuable remarks on the sternum in general. He distinctly adopts the Lamarckian theory for the loss of the keel, and again calls attention to the heterogeneous nature of the Ratitae. — (*Proc. zoöl. soc.*, 1882, 689.) J. A. J. [459

Pacinian corpuscles of birds. — Mlle. Joséphine Cattani has studied the corpuscles of Herbst in the leg of the fowl. The axis of the corpuscle is constituted by an extension of the nerve-fibre; the extension comprising not only the axis-cylinder, but also the medullary and Schwann's sheaths. At the point of entry the fibre is slightly constricted, and there is a Ranvier's node where the fibre reaches the corpuscle. Within the corpuscle the axis-cylinder becomes ribbon-like; the medullary sheath becomes thinner, and has a nucleus. The mass investing this terminal organ is composed of a web of fibres, with scattered ramified cells having oval nuclei; there are also two rows of cells with round nuclei along the nerve-fibre. The external envelope is a layer of connective tissue with very elongated nuclei. The nerve-fibre ends with a little flask-shaped dilatation, which has a granular matrix in which each fibrilla of the axis-cylinder ends in a little button. The author has also investigated the degeneration of these organs, after cutting the sciatic nerve; but this portion of her work lies rather in the domain of pathology. — (*Arch. ital. biol.*, iii. 326.) C. S. M. [460

Mammals.

The lingual sense-organs of Ornithorhynchus. — E. B. Poulton has continued his researches on the tongue (Science, i. 523) by studying that of Ornithorhynchus. The tongue is about two inches long, and has only a small part free. The posterior third forms a large rounded conical protuberance, pointing obliquely forwards, and bearing at its apex two corneous teeth. The anterior division is covered by horny papillae, and has numerous mucous glands. The posterior division is more complicated, bearing various organs on its dorsal surface: viz., numerous filamentous papillae; an arching fold, limiting the tongue behind; a median raphe, which does not reach the tip of the cone; and four gustatory pits, — one pair near together, in front; and one pair behind, widely separated.

The papillae upon the anterior division of the tongue are largest in front, and smaller (and more scale-like) towards the base of the tongue, and also extend over the inferior surface of the basal protuberance. Except a few in front, they are all cornified, pointed, and inclined backwards. In each of the interior of these papillae are lodged from one to four sub-epithelial sensory bulbs; a medullated fibre runs directly to each bulb, and there loses its sheath; while the axis-cylinder is continued into a spindle-shaped body within the bulb, which, for the rest, consists of a series of nucleated lamellar envelopes. Poulton compares these organs with the Pacinian corpuscles, and considers them tactile. The epithelium between the papillae is not cornified: in it are found the pore-like openings of the numerous mucous glands.

The epithelium of the overhanging ventral surface of the posterior protuberance is more specialized, in that four strata can be distinguished in it. Curiously, the outer stratum appears less corneous than that which it immediately overlies. The two teeth at the apex have a very thick corneous layer, which, however, does not cover their tips, but forms a ring around an apical spot of softer epithelium.

The dorsal surface of the protuberance is covered by a simple epithelium, with numerous hair-like papillae similar to those in Perameles (Science, i. 523). In all four of the gustatory pits is a ridge projecting from the base, and bearing the taste-bulbs under its surface. In the specimen examined the left posterior pit was (abnormally?) rudimentary. Each bulb lies in a papilla, which penetrates far into the epithelium, which is also pierced by a pore over each bulb. The terminal organ is the axial body (cell?) of the bulb, appended to the end of the nerve-fibre. The surrounding cells are sub-epithelial, and form a sheath around the axial body. This observation confirms the author's theory that the taste-bulbs arose as papillary sub-epithelial structures. The value of this theory was asserted in the abstract of the author's previous paper. Numerous serous glands open around the base of the gustatory ridges. Such glands appear to be very generally associated with the organs of taste. Around the pits are smooth muscles, which (at least, around the mouths of the anterior pair) distinctly form sphincters.

The gustatory ridges of Ornithorhynchus, if they rose to the surface and were shortened, would become like circumvallate papillae; if they remained long and became furrowed, they would resemble the foliate areas of rodents: hence Poulton considers that the ridges represent a primitive form from which both the principal types of elevated gustatory areas in mammals may have been derived. — (*Quart. journ. micr. sc.*, xxiii. 453.) C. S. M. [461

Lymphatic and blood vessels. — Dogiel describes the lymph-vessels of the renal capsule and gall-bladder of the dog. In the renal capsule two layers can be distinguished, the outer of which alone is vascular. Prof. Arnstein, in an appended note, states that the rudimentary homologue of the fatty envelope of other species is included in this outer layer. The lymphatics form a coarse network of large vessels, which are accompanied by blood-vessels, and spun over by a loose network of very fine capillaries, while in the meshes of the lymphatic network is an abundant collection of anastomosing blood-capillaries. Each mesh thus forms a vascular island. By this distribution the lymph-vessels are brought as far as possible from the blood-vessels, — an arrangement which is attained in various ways in other parts, and which is important for the perfect drainage of the tissues.

In the gall-bladder there are three sets of lymphatics, — a net for the mucosa, one for the muscularis, and a third for the serosa externa. These are all described and figured. — (*Arch. mikr. anat.*, xxii. 608.) C. S. M. [462

(*Man.*)

Branchial arches and clefts. — Cadiat publishes an article destined to serve as "an introduction to the history of the formation of the face and its different cavities: of the neck, thorax, pharynx, and lung;" also the peritoneum, pleurae, pericardium, respiratory cavities: and gills of fishes (!) The reporter regrets to have found in the article nothing but redescriptions of the pharyngeal apparatus of the embryo chick. As the facts have been familiar to embryologists for very many years, the object of the publication is not obvious. — (*Robin's journ. anat. physiol.*, xix. 38.) C. S. M. [463

Laws of dentition. — Magitot publishes a somewhat lengthy essay on this subject; but the article hardly contains original matter, and is written from a point of view too exclusively that of the dentist. — (*Robin's journ. anat. physiol.*, xix. 59.) C. S. M. [464

ANTHROPOLOGY.

Ancient Orkney-Islanders. — Dr. J. G. Garson has made a very thorough study of the crania and other remains of the ancient inhabitants of the Orkney Islands. His paper takes up in detail their dwellings, stature, limb-bones, and skulls, the last named with great detail, and expresses his results in elaborate tables. The author comes to the following conclusions: —

It is evident that in this series of skulls we have not a single pure race to deal with, but two distinct races, which have existed at probably three different periods. The first and apparently the ruder race seems to be the long-headed people, represented by the skulls from Skerrabrae and Saverough. We have next the round-headed race, which probably occupied the country for a considerable time. The time when these races inhabited the islands is quite uncertain. The abundance of deer-horn at Skerrabrae indicates the presence of these animals, which would probably be associated with forests. When the Romans visited the Orkneys, their historians tell us that there were no forests there. Also the absence of metals, and the rude implements, point to a people in the unpolished stone period. Some evidence is also found in the washing-away of the coast. The round-headed race seems to have lived just before or at the beginning of the bronze period. — (*Journ. anthrop. inst.*, xiii. 54.) J. W. P. [465

The Jutish type of face. — The peculiarity of the Jutish features consists in the form of the nose and mouth. There is no nasal point or tip, properly so called, as in the Danish, Cymric, and Iberian face, and their inter-crosses; nor is there any approach to the slight bulb which distinguishes the Saxon. The end of the nose is rounded off somewhat sharply, and the septum descends considerably below the line of the nostrils. The lips are less moulded or formed, and resemble the Iberian rather than the Saxon type. The lower lip, more particularly, is thick and deep. Mr. J. Park Harrison has been searching for specimens of the Jutish countenance in Kent, Isle of Wight, and in South Hants. — (*Journ. anthrop. inst.*, xiii. 86.) J. W. P. [466

Egyptian mechanical methods. — Petrie, who is the author of a treatise on ancient metrology, has lately turned his attention to ancient Egyptian processes. Though much labor has been bestowed on the literary remains of Egypt and the description of monuments, little attention has been given to finding out the tools and methods by which their results were reached. The first conclusion to which Mr. Petrie comes, is that the stone-cutting was performed by means of graving-points far harder than the material to be cut. These points were bedded in a basis of bronze; and in boring, the cutting action was not by grinding with a powder, as in a lapidary's wheel, but by graving with a fixed point, as in a planing-machine. From discovering spiral grooves in diorite and granite, at least $\frac{1}{10}$ of an inch in depth, the author supposes that an instrument was used of sufficient hardness to penetrate the material that far at a single turn. In this, however, he was corrected by Mr. Evans. The simplest tool used was a straight bronze saw set with jewels; but there is proof of one circular saw which must have been $6\frac{1}{2}$ inches in diameter. For hollowing the insides of stone objects, the inventive genius of the fourth dynasty exactly anticipated modern devices by adopting tubular drills varying from $\frac{24}{100}$ of an inch in diameter and $\frac{1}{30}$ of an inch in thickness, to 18 inches in diameter. Other drills, not tubular, were used for small holes, one measuring $1\frac{2}{10}$ inches long and $\frac{8}{100}$ of an inch in diameter. But this is surpassed by the Uaupes of South America, who drill holes in rock-crystal by the rotation of a pointed leaf-shoot of plantain, worked with sand and water. The writer of this note has seen, in Porto Rico, stone beads of the hardest material, 2 inches long, bored longitudinally with an orifice $\frac{1}{16}$ of an inch in diameter. The Egyptians understood rotating both the tool and the work. For the finishing of vases, a hook-tool must have been used; but the early Egyptians were familiar, not only with lathes and jewel-turning tools, but with mechanical tool-rests, and sweeping regular arcs in cutting. In addition to the tools mentioned, are to be noticed those for dressing out drilled cores, stone hammering and smoothing, saws with curved blades, mallets, chisels, adzes, and bow-drills. For marking and indicating the plane of the stone, red-ochre paint was used in a variety of ways, well studied out by Mr. Petrie. Rock-excavation, both for saving the stone and for the creation of vaults and chambers, was altogether an affair of drilling. Granite bowlders were utilized in the pyramids, but the best stones were taken from quarries. The method of handling these immense masses is not known. Mr. Petrie concludes with a sensible remark upon the oft-alleged inhumanity of the pyramid and temple builders. To require a man every six years to serve upon the public works, during the season when he could do nothing else, would certainly not be a great hardship. — (*Journ. anthrop. inst.*, xiii. 88.) O. T. M. [467

Navajo mythology. — The Navajos, says Dr. Washington Matthews, speak of five worlds, in four of which our fathers lived ere reaching this. In the first world were the first man, the first woman, and the coyote. In the second world were two other men, the sun and the moon people, and at the four corners were the people of the cardinal points. An amour of the sun with first woman led to the ascent of all to the third world, where they found another race of people living in the mountains. Here coyote stole the children of Ticholtsodi (he who seizes you in the sea), who caused a deluge to cover the earth. The emigrants ascended to the fourth world through the growth of a hollow reed. Here a disturbance arose concerning the relative value of men and women, which resulted in favor of the men. After the lapse of some years they were pursued hither by the giant looking for his cubs, which coyote still concealed. The floods rose, and they were let up into world five by the badger and the locust. The cubs were thrown down to the giant, and the waters subsided. Then came the fitting-up of the world for their abode. At this point of the myth are several very pretty origin-stories about the dry land, the mountains, the sun and moon, the making of climate, etc. Here is one. "On the fifth day the sun arose, climbed to the zenith, and stopped. Coyote said, 'The sun stops because he has not been paid: he demands a human life for every day that he labors.' At length a woman, the wife of a great chief, ceased to breathe, and grew cold. The sun travelled down the western sky, and passed behind the western mountain." There is a similar moon myth. Then follow the confusion of tongues, the making of the stars, the lengthening of the seasons, the forming of snow, the planting of corn. At this juncture, on account of the wickedness of mankind, first woman made the five great destroyers, — Yeitso, Tsinahale, Delgeth, Tseta-holtsil-tahli, and Binaye. She also took to rear a foundling girl, Estsanatlehi. The latter, impregnated by the sun, brought forth twins, who, by the aid of their father, slay the five great destroyers of mankind. The stories of these Herculean labors is charmingly told, and is full of theories about the causes of familiar things, such as the birds, the shunning of a mother-in-law. The mother of the giants repeopled the world, built pueblos, established the gentes. The giants may still be seen in the waters of the San Juan, and the mother continues to send to the Navajos the snow, the spring thaw, the soft rain, the corn, and the green grass. — (*Amer. antiq.*, v. 207–224.) J. W. P. [468

EARLY INSTITUTIONS.

A history of guilds. — A Mr. Waterford, barrister-at-law, is writing a history of English guilds. He has already described the aims and purposes of the guilds. He has also described their history, and the history of public opinion and legislation regarding them. He is now taking up their geographical distribution in the different counties and towns. Extracts are given from the records. The work promises to be one of interest and value. The history of trade unions is a subject which deserves especial attention in these days. It is a very difficult subject, however, and by no means mastered as yet. Contributions towards its elucidation are therefore very welcome. — (*Antiq. mag.*) D. W. R. [469

The Merovingian grants of immunity. — These grants, a chief source of feudalism, are not considered by M. Fustel de Coulanges to have been confined to ecclesiastics, as is usually assumed. The grants to ecclesiastics were no doubt the most numerous, and the documents are at any rate better preserved; but lay proprietors received precisely the same powers. The essential feature of the grant he regards as the exclusion of the public officials from the territory of the immunity, whether for judicial, fiscal, or military purposes. Exemption from financial burdens was a natural but not necessary nor universal consequence. In this he agrees with Heusler, differing from him, however, in holding that the grantee was absolutely removed from all relation to the public official, the count, and stood only under the king; while Heusler considers that he only became an intermediary between his tenants and the count. The result of these grants was to completely break up the administrative system of the Frank empire by removing great stretches of territory from the authority of the public official, and practically to make the proprietor an irresponsible master over his free tenants as well as his serfs. The same effects followed the grants of *mundiburdium*, or protection, by which the proprietor entered into a purely personal relation to the king, ceasing to be under the authority of the count. This substitution of a personal relation for the political one of subject and ruler is also of the essence of feudalism. It is not possible to decide whether the grants of immunity or those of *mundiburdium* were the earlier. Immunity, however, applying primarily to the land, necessarily included the personal relation; while *mundiburdium*, by an equal necessity, led to immunity. The article is written in the interesting style and with the characteristic lucidity of the author, and forms a most important contribution to the study of the origin of feudalism. — (*Rev. hist.*, July–October.) W. F. A. [470

NOTES AND NEWS.

A CABLE despatch was received Nov. 30, at Harvard college observatory, announcing the discovery of a small planet by Palisa at Vienna. Its position Nov. 28, 13 h. 20 m., Greenwich time, was, right ascension, 3 h. 19 m. 14 s.; declination, north, 15° 52′ 17″; daily motion in right ascension, — 48″; in declination, nothing. It is of the twelfth magnitude. The planet was readily identified at Harvard college observatory, and was observed by Mr. Wendell as follows: Nov. 30, 9 h. 30 m., Cambridge time; right ascension, 3 h. 17 m. 27 s.; declination, north, 15° 51.1′.

— While the revenue steamer Corwin was cruising on the coast of Alaska and in the north-west Arctic Ocean in 1881, Dr. Irving C. Rosse, her medical officer, found leisure to prepare a series of medical and anthropological notes, which have just been published by the Treasury department. The medical notes, although they exhibit the mind of a keen observer, are rather technical than racial: there is a short chapter on medical and surgical subjects, however, p. 25. The author holds that the marks of distinction between the Eskimo and the Chukchi are not very plain. At Kotzebue Sound many of the natives are tall and of a commanding appearance. Uniformity of features, so commonly attributed to the Eskimo, has frequent exceptions; many of the natives exhibiting countenances of Chinese, Jewish, Milesian, or even Mulatto cast. The experiments of strength and agility in rowing, racing, throwing stones, and lifting, given on p. 29, are valuable contributions to anthropometry. The popular notion regarding the great appetite of the Eskimo is one of the current fallacies, according to Dr. Rosse. As to the commercial connection between the two continents, natives cross and recross Bering Strait to-day on the ice and in primitive skin canoes, which have not been improved since the days of prehistoric man. With a view to finding out whether any linguistic affinity existed between the Japanese and the Eskimo, Dr. Rosse caused several Japanese boys employed on the Corwin to talk on numerous occasions to the natives, both on the American and Asiatic coast; but in every instance they were unable to understand the Eskimo, and assured him that they could not detect a single word that bore any resemblance to words in their own language. The language varies greatly from point to point. The interpreter taken at St. Michaels could with difficulty understand the natives of Point Barrow, while at St. Lawrence Island and on the Asiatic side he could understand nothing at all. The author happily likens spoken languages to those species of animals which are still in a plastic condition and are undergoing farther development. The Eskimo tongue is one of these, and yields with facility to almost any external influence.

Dr. Rosse speaks slightingly and flippantly of philological studies, and holds that the observation of habits in satisfying the demands of nature is a surer guide to racial affinities. The dietetic value of seal, bear, walrus, eider-duck, whale, and reindeer, is discussed; and we are led to believe that the Eskimo are by no means to be pitied for their miserable food. Says Dr. Rosse, "We dined occasionally on fresh trout, young wild duck, and reindeer. . . . There is scarcely any better eating in the way of fish than Coregonus, and certainly no more dainty game than young wild geese and ptarmigan." The cranberries and a kind of kelp are the only vegetable food. Eggs in all states are eagerly devoured, though the women will not take gull's eggs. Game is both plentiful and very tame.

Courtship and marriage are exceedingly simple, parturition is easy, families are small, and mortality among the new-born excessive. The description of the carrying of infants and the plays of children exhibit in the author a genuine sympathy absolutely necessary in an observer of natural history. The personal ornamentations are chiefly tattooing and wearing labrets. The native has no music in his soul, although rare instances of acquired facility in singing and playing are recorded. He is a born dancer or jumper, however, mingling this pastime with all his feasts. Dr. Rosse speaks in the highest terms of the Eskimo art talent and of the facility shown by some in learning the art of the higher race. Of the intelligence of the race the author has a high opinion. In speaking of their crania, Dr. Rosse confirms the results of Dr. Kohlmann, that there is no fixed Eskimo cranial type. As to character, uncontaminated, they are models of truthfulness and honesty; but as to chastity, Herder was far from truth when he wrote, "The blood of man near the pole circulates slowly, the heart beats but languidly: consequently the married live chastely, the women almost require compulsion to take upon them the troubles of a married life."

Owing to his hard life, the conflict with his circumstances, and his want of foresight, the Eskimo soon becomes a physiological bankrupt: and, his stock of vitality being exhausted, his bodily remains are covered with stones, around which are placed wooden masks, and articles that have been useful to him during life; or they are covered with driftwood, and the weapons and personal effects placed near by, in response to the sentiment commemorated by Schiller in 'Bringet hier die letzten gaben.'

— The Ottawa microscopical society held a conversazione on Nov. 20, at which nearly three hundred invited guests were entertained by the president and members. The admirable arrangement of the rooms allowed of a varied programme. Microscopes of various makers and models, and of highest grade, were set out in the upper story of the building; while the lower hall was devoted to music, elocution, the oxy-hydrogen microscope, and the stereopticon. In the hands of the Rev. Dr. Balland, of the College of Ottawa, the gas-microscope and gas-lantern charmed all by the novelty and brilliancy of the objects and views presented to them. The entertainment lasted nearly three hours, and a repetition is eagerly demanded.

The general meetings of the society will be held this winter on Dec. 18, Jan. 15, Feb. 19, and March 18, at eight P.M., in the offices of the Geological survey.

— In accordance with the vote passed at the public meeting of the Archaeological institute of America, reported in SCIENCE, No. 41, the Hon. Samuel C. Cobb and Messrs. Henry Lee, William Endicott, jun., Oliver W. Peabody, and John C. Phillips have been appointed a committee to solicit subscriptions for the publication of the report of the investigations at Assos and for the general work of the institute. Twenty thousand dollars are needed; and subscriptions may be sent to either of the members of the committee, or to Henry L. Higginson, Esq., treasurer of the institute, No. 44 State Street, Boston.

— At the third annual meeting of the Natural science association of Staten Island, held in the village hall, New Brighton, Nov. 10, Dr. A. L. Carroll was chosen president; Samuel Henshaw, treasurer; Charles W. Lang, recording secretary; Arthur Hollick, corresponding secretary; and W. T. Davis, curator. The society numbers seventy, and has a balance in the treasury. Objects of interest were exhibited at this meeting by seven members, and consisted very largely of specimens collected in the immediate vicinity, — the highest sign of activity.

— The editor of the *American monthly microscopical journal* announces that the office of publication will be removed to Washington with the beginning of 1884.

— The Russian academy of science held its centennary anniversary at St. Petersburg with much ceremony on the second of last month, under the presidency of Count Tolstoy, the Russian minister of the interior.

— The *Moniteur industrielle* announces that the International exhibition at Marseilles opened on the 15th of November, and remains open until April 31, 1884. The programme is extensive, and, on the whole, embraces much the same range of subjects as the London fisheries exhibition.

— After the electrical exhibition in Paris, a number of French electricians formed themselves into a club, which has met once a month for a dinner. From this small beginning there has developed an 'International society of electricians.' The society numbers more than nine hundred members from twenty nationalities. Information may be had from Georges Berger, 99 Rue de Grenelle, Paris.

— Mr. Charles A. Ashburner of the State geological survey is completing his surveys and examinations in Cameron, Elk, and Forest counties, Penn. Mr. Ashburner's report, to be accompanied by maps and sections, will be published late in the winter, and will contain much information of interest to the coal and oil operators in this section of the state.

— The next issue of the Library of aboriginal American literature, published by Dr. D. G. Brinton, Philadelphia, will be 'The comedy of Gueguence,' a play written and acted by the natives of Nicaragua. It dates from the seventeenth century, and is written in a curious dialect, half Aztec and half Spanish. It will be ready early in December.

— An itinerary has been issued of the first part of the map of the route of the Alaska military reconnaissance of 1883 by Lieut. Schwatka. The total length of raft-journey on the Yukon River from Lake Lindeman to Nuklakayet was 1,303.2 miles, being the longest raft-journey in the interest of geographical science. He gives the length of the Yukon River as 2,043.5 miles.

— At the meeting of the Engineers' club of Philadelphia, Nov. 17, Mr. Edw. I. H. Howell presented a sketch of the practice and peculiarities of the English machinists with regard to machine-tools. He also exhibited specimens of polished shafting, from $1\frac{1}{8}''$ to $2\frac{3}{4}''$ in diameter, cold drawn, like wire. The secretary, Howard Murphy, read an illustrated paper by Mr. G. T. Gwilliam, upon the methods of making and placing the mattresses and fascines at the extension of the Delaware Breakwater harbor. The secretary presented notes, by Mr. John J. Hoopes, to illustrate methods of computing tables by successive additions instead of separate calculations. Mr. John Haug presented illustrated notes upon boiler construction, touching especially upon what should be shown in drawings and specifications for boilers. Mr. George S. Strong exhibited specimens of cylindrical and corrugated flues; the former readily yielded to the pressure of the fingers, while the latter was trampled upon without injury. The secretary read, for Mr. C. J. Hexamer, a description of his experiments upon, with a discussion of the causes of, dust-explosions in mills. Mr. William A. Ingham considered that some explosions in coal-mines are probably attributable to the immense quantity of fine dust in the air; and Mr. T. Mellon Rogers, in response to Mr. Hexamer's comments upon the general absence of adjustable rolls in Philadelphia mills being a common cause of ignition by the friction of foreign metallic particles in the stock, spoke of their general use in the west.

— The mathematical section of the Washington philosophical society has resumed its sessions. At the meeting held Nov. 21, Mr. C. H. Kummell discussed the theory of errors as practically tested by target-shooting, in which he showed the effect of a difference of precision in the vertical and horizontal directions, and of taking account of the lost shots on the formulae employed.

— C. G. Stewart of St. Thomas's hospital, London, and Mr. G. Lathom Browne of the Midland circuit, have published the reports of various trials for murder by poisoning, from the trial of Tawell to that of Dr. Lamson. The book also gives directions for analysis, and points out difficulties that have occurred, or are likely to occur, in proving the presence of poison to a jury. The *Chemical news* considers the book "indispensable to all chemists who practise in toxicology, of great value to the medical profession generally, and doubtless no less so to solicitors and counsel who may be concerned in poisoning cases."

— The *Industrie-blätter* of Aug. 4 reports an ingenious fraud in jewelry. Thin plates of some precious stone, as for instance of emerald, have melted glass of the same color as the stone poured on one side. The real stone is set outside, so that, when tried, the jewel presents every appearance of being genuine and of the right hardness. These stones are called in the trade *pierres fines doublées*. The only test is to hold the stone edgewise, when, of course, the two sides will show different refraction. Any connoisseur will thus be able to detect the fraud; but, if set, this could hardly be done.

— The *Moniteur des fils et tissus* calls attention to a description of vegetable wool called kapoc. It comes from Java, and a specimen is on view at the Amsterdam exhibition. It arrives at Amsterdam in its leathery covering, being itself enveloped in the seeds. It is then freed from both, and is carded so as to make a very light mattress wool, worth about $8\frac{3}{4}d$ per pound. One of the houses engaged in this operation had made trials in spinning and dyeing this material; but the filaments are said to be like strings, and their industrial application consequently a matter of uncertainty.

— The *Industrie zeitung* gives a description of the source of the much advertised Hunyadi Janos water. Fourteen springs rise in a marsh near the town of Ofen in Hungary, which is the property of Herr A. Saxlehnes of Budapesth. Four of the strongest springs flow into a cement-lined cistern, whence the water is pumped into a second reservoir and cleared, then passed through other purifying-vessels, until it is bottled by an ingenious arrangement, ten bottles being filled at once. The yearly sale amounts to about three million bottles.

— Caillaud communicates to the Geographical society of Paris some statements in regard to a plant of the strychnine family, native to Tonquin, to which remarkable virtues are ascribed. It is called by the Annamites, who make use of it, 'hoangnan.' It grows in the mountains which separate the valley of Mekong from southern Tonquin, and is a vine whose bark, in which the active principle exists, is a violent poison. Its use was communicated by a native convert to the missionaries. M. Lesserteur, formerly a missionary in Tonquin, and now director of the seminary of foreign missions, has published a pamphlet, in which he recounts numerous cases in which a cure was effected. Dr. F. Barthélemy of Nantes has also made a special study of the drug, which appears to act as an alterative and antispasmodic. It is also under investigation by the medical school of Alfort. Cures of active hydrophobia are claimed for it, and several cases mentioned in detail. It is also said to be an antidote to the venom of serpents, and to relieve cutaneous diseases. While under the effect of the drug, it is said that alcoholic liquor or heating food must be absolutely avoided as liable to induce active poisoning. Altogether, while there may be a valuable medical agent in this new drug, the accounts given of it recall those which heralded the introduction of the notorious South-American 'cundurango.'

SCIENCE.

FRIDAY, DECEMBER 14, 1883.

THE SIGNAL-SERVICE AND STANDARD TIME.

It has been announced that the chief signal-officer has ordered his corps of observers to continue to be governed by the local time of their respective stations. It is difficult to understand this action on the part of Gen. Hazen. It would seem, that, next to the transportation companies, the weather bureau would be most benefited by the adoption of a system of time which would render all observations strictly and easily comparable with each other. The position taken by the service is all the more remarkable, when it is remembered that only two or three years ago its chief was himself a warm advocate of the new scheme, and declared his anxiety to further its introduction in every way in his power. It will be everywhere admitted that the adoption of standard time by all observers would greatly aid in securing its acceptance by the people generally; and it is to be hoped that it will be shortly done, unless some grave reason, which is certainly not apparent, exists for its rejection.

A SUGGESTION TO AUTHORS.

Authors who republish in a separate form papers originally printed in society transactions or journals should be careful to preserve the original pagination of the serial from which they are extracted, or to indicate the same in some clear way for purposes of ready and correct reference. It would really be worth calling a convention of our scientific societies for the purpose, if a reform could be effected in this matter. Time is too precious to be wasted in search, often fruitless, for an original source, when it could have been indicated, without additional cost, upon the separated copies. It would also be far better if the original page itself could be left intact without overrunning: otherwise errors of reference will be entailed on posterity, which will prove justly exasperating to the student obliged to consult the vast literature of that coming day. The reform cannot come too soon nor be too thorough.

EXPERIMENTS IN BINARY ARITHMETIC.

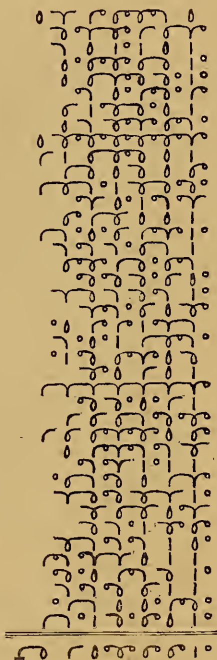
Those who can perform in that most necessary of all mathematical operations, simple addition, any great number of successive examples, or any single extensive example, without consciousness of a severe mental strain followed by corresponding mental fatigue, are exceptions to a general rule. These troubles are due to the quantity and complexity of the matter with which the mind has to be occupied at the same time that the figures are recognized. The sums of pairs of numbers from zero up to nine form fifty-five distinct propositions that must be borne in memory, and the 'carrying' is a further complication. The strain and consequent weariness are not only felt, but seen, in the mistakes in addition that they cause. They are, in great part, the tax exacted of us by our decimal system of arithmetic. Were only quantities of the same value, in any one column, to be added, our memory would be burdened with nothing more than the succession of numbers in simple counting, or that of multiples of two, three, or four, if the counting is by groups.

It is easy to prove that the most economical way of reducing addition to counting similar quantities is by the binary arithmetic of Leibnitz, which appears in an altered dress, with most of the zero-signs suppressed, in the example below. Opposite each number in the usual figures is here set the same according to a scheme in which the signs of powers of two repeat themselves in periods of four: a very small circle, like a degree-mark, being used to express any fourth power in the series; a long loop, like a narrow 0, any square not a fourth power; a curve upward and to the right, like a phonographic *l*, any double fourth power; and a curve to the right and downward, like a phonographic *r*, any half of a fourth power; with a vertical bar to denote the absence of three successive powers not fourth powers. Thus the equivalent for one million, shown in the example slightly below the middle, is 2^{16} (represented by a degree-mark in the fifth row of these marks, counting from the right) plus $2^{17}+2^{9}$ (two *l*-curves in the fifth and third places of *l*-curves) plus $2^{18}+2^{14}+2^{6}$ (three loops) plus 2^{19} (the *r*-curve at the extreme left); while the absence of 2^3, 2^2, and 2^1, is shown by the vertical stroke at the right. This equivalent expression may be verified, if desired, either

Example in addition by two notations.

77,823,876
14,348,907
8,654,912
5,764,801
4,635,857
1,594,323
6,417,728
4,782,969
83,886,075
34,012,224
2,903,111
48,828,125
1,724,826
7,529,536
43,344,817
10,000,000
8,334,712
1,953,125
11,308,417
759,375
21,180,840
9,765,625
18,643,788
1,000,000
44,739,243
1,889,568
2,517,471
40,353,607
4,438,414
1,679,616
23,708,715
11,390,625
945,754
823,543
15,308,805
60,466,176
30,685,377
10,077,696
19,416,381
43,046,721

740,685,681



by adding the designated powers of two, from 524,288 down to 64, or by successive multiplications by two, adding one when necessary. The form of characters here exhibited was thought to be the best of nearly three hundred that were devised and considered, and in about sixty cases tested for economic value by actual additions.

In order to add them, the object for which these forty numbers are here presented in two notations, it is not necessary to know just *why* the figures on the right are equal to those on the left, or to know any thing more than the order in which the different forms are to be taken, and the fact that any one has twice the value of one in the column next succeeding it on the right. The addition may be made from the printed page, first covering over the answer with a paper held fast by a weight, to have a place for the figures of the new answer as successively obtained. The fingers will be found a great assistance, especially if one of each hand be used, to point off similar marks in twos, or threes, or fours, — as many together as can be certainly comprehended in a glance of the eye. Counting by fours, if it can be done safely, is preferable, because most rapid. The eye can catch the marks for even powers more easily in going up, and those for odd powers (the *l* and *r* curves) in going down, the columns. Beginning at the lower right-hand corner, we count the right-hand column of small circles, or degree-marks, upwards: they are twenty-three in number. Half of twenty-three is eleven, and one over: one of these marks has therefore to be entered as part of the answer, and eleven carried to the next column, the first one of *l*-curves. But since the curves are most advantageously added downward, it is best, when the first column is finished, simply to remember the remainder from it, and not to set down any thing until the bottom is reached in the addition of the second column, when the remainders, if any, from both columns, can be set down together. In this case, starting with the eleven carried, and counting the number of the *l*-curves, we find ourselves at the bottom with twenty-four, — twelve to carry, and nothing to set down except the degree-mark from the first column. With the twelve we go up the adjoining loop-column, and the sum must be even, as this place is vacant in the answer; the *r*-curve column next, downward, and then another row of degree-marks. The succession must be obvious by this time. When the last column, the one in loops to the extreme left, is added, the sum has to be reduced to unity by successive halvings. Here we seem to have eleven: hence we enter one loop, and carry five to the next place, which, it must be remembered, is of *r*-curves. Halving five, we express the remainder by entering one of these curves, and carry the quotient, two, to the degree-mark place. Halving again gives one in the next place, that of *l*-curves; and the work is complete.

It is recommended that this work be gone over several times for practice, until the appearance and order of the characters, and the details of the method, become familiar; that, when the work can be done mechanically and without hesitation, the time occupied in a complete addition of the example, and the mistakes made in it, be carefully noted; that this be done several times, with an interval of some days between the trials, and the result of each trial kept separate; that the time and mistakes by the ordinary figures in the same example, in several trials, be observed for comparison. Please pay particular attention to the difference in the kind of work required by the two methods in its bearing on two questions, — which of them would be easier to work by for hours together, supposing both equally well learned? and in which of them could a reasonable degree of skill be more readily acquired by a beginner? The answer to these questions, if the comparison be a fair one, is as little to be doubted as is their high importance.

Eight volunteer observers to whom this example has already been submitted showed wide difference in arithmetical skill. One of them took but a few seconds over two minutes, in the best of six trials, to add by the usual figures, and set down the sum, but one figure in all the six additions being wrong; another added once in ten minutes fifty-seven seconds, and once in eleven minutes seven seconds, with half the figures wrong each time. The last-mentioned observer had had very little training in arithmetical work, but perhaps that gave a fairer comparison. In the binary figures she made three additions in between seven and eight minutes, with but one place wrong in the three. With four of the observers the binary notation required nearly double the time. These observers were all well practised in computation. Their best record, five minutes eighteen seconds, was made by one whose best record was two minutes forty seconds in ordinary figures. The author's own best results were two minutes thirty-eight seconds binary, and three minutes twenty-three seconds usual. He thus proved himself inferior to the last observer, as an adder, by a system in which both were equally well trained; but a greater familiarity (extending over a few weeks instead of a few hours) with methods in binary addition enabled him to work twice as fast with them. Of the author's nine additions by the usual figures, four were wrong in one figure each; of his thirty-two additions by different forms of binary notation, five were wrong, one of them in two places. One observer found that he required one minute thirty-three seconds to add a single column (average of five tried) by the usual figures, and fifteen seconds to count the characters in one (average of six tried) by the binary. Though these additions were rather slow, the results are interesting. They show, making allowance for the greater number of columns (three and a third times as many) required by the binary plan, a saving of nearly half; but they also illustrate the necessity of practice. This observer succeeded with the binary arithmetic by avoiding the sources of delay that particularly embarrass the beginner, by contenting himself with counting only, and not stopping to divide by two, to set down an unfamiliar character, or to recognize the mark by which he must distinguish his next column. One well-known member of the Washington philosophical society and of the American association for the advancement of science, who declined the actual trial as too severe a task, estimated his probable time with ordinary figures at twenty minutes, with strong chances of a wrong result, after all.

These statistics prove the existence of a class of persons who can do faster and more reliable work by the binary reckoning. But too much should not be made of them. Let them serve as specimens of facts of which a great many more are to be desired, bearing on a question of grave importance. Is it not worth our while to know, if we can, by impartial tests, whether the tax imposed on our working brains by the system of arithmetic in daily use is the necessary price of a blessing enjoyed, or an oppression? If the strain produced by greater complexity and intensity of mental labor is compensated by a correspondingly greater rapidity in dealing with figures, the former may be the case. If, on the contrary, a little practice suffices to turn the balance of rapidity, for all but a small body of highly drilled experts, in favor of an easier system, the latter must be. This is the question that the readers of Science are invited to help in deciding. The difficulties attending a complete revolution in the prevalent system of reckoning are confessedly stupendous; but they do not render undesirable the knowledge that experiment alone can give, whether or not the cost of that system is unreasonably high; nor should they prevent those who accord them the fullest recognition from assisting to furnish the necessary facts.

Those who are willing to undertake the addition on the plan proposed or on any better plan, or who will submit it to such acquaintances, skilled or unskilled, as may be persuaded to take the trouble to learn the mechanism of binary adding, will confer a great favor by informing the writer of the time occupied, and number of mistakes made, in each addition. All observations and suggestions relating to the subject will be most gratefully received.

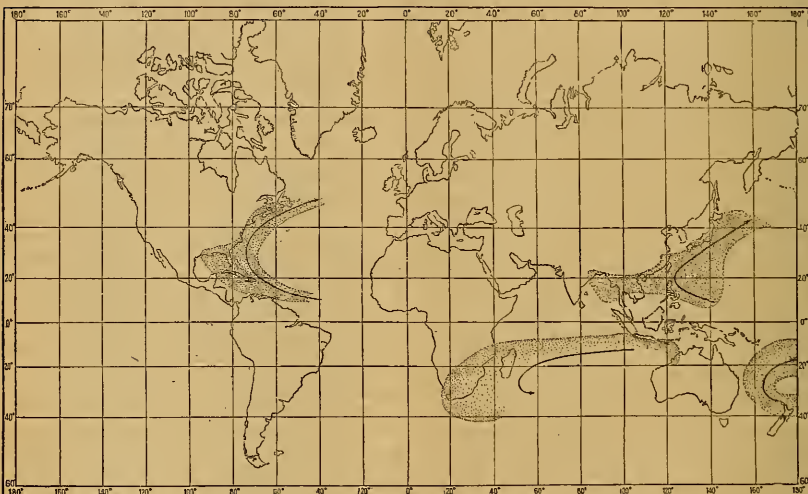
Henry Farquhar.

Office of U. S. coast-survey, Washington, D.C.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — VI.

Having seen how storms arise, and examined the general motions of their spiral winds, we must next consider their progression from place to place. It is now a familiar fact, that storms do not remain stationary, but advance forth. The apparently lawless winds of a storm could be reduced to system if they were supposed to blow around a centre which itself has a progressive motion. In nearing the centre, the barometer falls, and the winds increase their strength. The manner and cause of the progressive motion must now be examined.

The four regions where tropical storms move into temperate latitudes — the seas south and east of India and China, and south-east of the United States, in the northern hemisphere; and those east of Madagascar and (probably) of Australia, in the southern hemisphere — are



THE REGIONS OF TROPICAL CYCLONES. (TAKEN FROM STIELER'S ATLAS.)

at a velocity of from five to fifty miles an hour along a line known as their track. Although perceived by Franklin about 1750, this, as well as their whirling motion, first found full and satisfactory proof at the hands of Dove of Berlin (1828), and Redfield of New York (1831). The latter gave the more numerous examples, and was the first to explain the motions of storm-winds at sea. The method of his discovery was simple enough. Information concerning the storm was gathered from all attainable records, and the condition of the winds and weather was plotted for certain hours. At once the result stood clearly all crossed by storm-tracks, running first westward near the equator, then turning toward the pole, and passing around the apex of a parabolic curve near latitude 30°, into an obliquely eastward course. The more numerous storms of temperate latitudes have less regular tracks, but are nearly always characterized by a strong eastward element in their motion; their chief variations to the right or left being dependent on thermal changes with the seasons, and on the configuration of land and water which they traverse. There have been four causes suggested to determine the progression of the storm-centre: namely, the general winds of the region, and especially the stronger and less

[1] Continued from No. 44.

variable upper currents; the supply of warm, moist air, and consequent occurrence of heavy rain; the relative strength of the inblowing winds; and a certain effect of the earth's rotation. All these causes of progression are variable in amount, and in relation to one another; and it is therefore natural to find their resultant inconstant.

The first-named cause is the most evident, the most powerful, and was the first recognized. The general or planetary circulation of the winds will require that any disturbance in the moving atmosphere shall partake of its motion, and be carried along in the direction of the current within which it is generated. Thus a storm arising in the equatorial calms is carried westward as soon as it attains sufficient height to reach the upper current, which must there move from east to west. No equatorial cyclone has ever been observed moving eastward. On approaching the western shores of the ocean, a part, at least, of the general winds, turns toward the poles, as may be seen on any wind-chart, and in latitude 25° or 30° passes from the region of the tropical winds into the system of the prevailing westerly winds of temperate latitudes. The storms have a strikingly similar course, and, on the western side of the oceans in these latitudes, never move towards the equator. Their further progress, and that of the many storms of the temperate zones, is easterly, with a leaning towards the pole while crossing the oceans, and a variable north-easterly or south-easterly advance on the continents. No storm has been found crossing the North Atlantic from east to west, or moving from our Atlantic coast to the plains beyond the Mississippi. Additional evidence of this style of bodily transference of storms will be given in considering the relative strength and the direction of their spiral winds on different sides of the centre.

The importance of the condensation of vapor and consequent rainfall in decreasing the cooling of the central up-draught, and so increasing its strength, has already been shown. In the explanation of this process, it was tacitly assumed that all the surface-indraught was equally warm and moist, so that condensation and rain would occur symmetrically about the centre of low pressure. It will now be seen, that, when a storm-centre is supplied from areas of unequal warmth and moisture, symmetrical cloud-forming and rain-falling on all sides will be impossible; there will be more rain, and hence less cooling, on one side than on the other; and just as the liberation of 'latent heat' aided in the formation of the first central barometric depression, so it will now tend to displace this centre to the side where the greatest amount of rain falls. If no other cause but this acted, the storm would advance regularly toward the region of heaviest precipitation: but this advance will not be like the bodily transference of the rotating winds effected by the general atmospheric currents; it will be rather the abandoning of one centre of attraction as a stronger one is created beside it, — the continual filling-up of one depression, and production of another. This may be illustrated by a modification of fig. 8, given here in fig. 12, in which the dotted lines show the gradients and winds established at a certain period of the storm. Let it be supposed that warmer, moister winds enter on the right, and cooler, drier winds, on the left. Where cooler, the air will be contracted, and the isobaric surfaces depressed: where warmer, from its own warmth, as well as from that of the condensing vapor, the air will be expanded, and the isobars elevated, as shown in full lines in the figure. The gradients will then be unsymmetrical about the original centre; and the previous motion of the winds will be accelerated at some points, retarded or reversed at others. As a result, the pressures at the surface will be changed from their previous arrangement to a new one, shown in fig. 13, in which the region of least pressure has moved to the side of the warmer winds and heavier rains. Any further inflow of the surrounding air must now be to the new low-pressure centre: in other words, the storm has advanced to the right. The process will be continuous as long as the winds on opposite sides of the storm are unlike.[1] Having thus

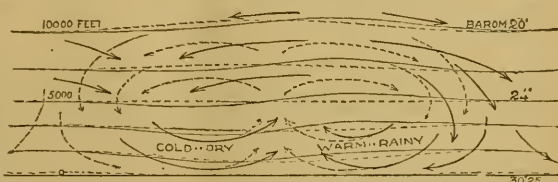


Fig. 12.

[1] Fig. 12 may serve further to explain the retarded arrival of the centre of low pressure at altitudes of a mile or more above

seen the general action of this cause of motion, it must now be applied more directly. There are two causes of rain in a cyclonic storm, — one from the expansion and cooling of the moist air as it enters the district of low pressure, and rises in the central up-draught; the other from the advance of the wind from a warmer into a cooler region. The first of these will generally be nearly symmetrical about the storm-centre, and hence not productive of any progressive motion: the second will as generally be unsymmetrical. In fig. 14, for the northern hemisphere, the parallel lines represent normal east and west isotherms, showing the usual decrease of temperature to the north. Of the several winds blowing inward to the storm-centre, *A* and *B*, which advance almost along the same isotherm, will not be seriously changed in temperature by their change of place; *C*, which comes from a cooler to a

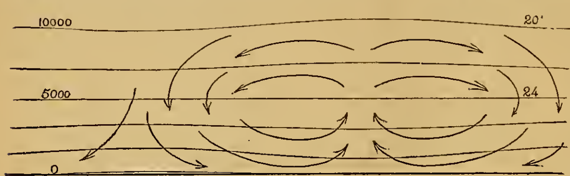


FIG. 13.

warmer district, will consequently increase its capacity for moisture, and be a clear, cold, drying wind; but *D* will be chilled, and must produce heavy clouds and strong rain somewhere about the shaded part of the figure; and the storm-centre will then be transferred toward the middle of this rainy district.

Standing on the warm side of the storm, the centre will appear to move nearly along the isotherms to the right. Actual isotherms seldom follow lines of latitude, and always vary their position with the seasons, especially along continental borders. Thus, over western Europe and the eastern margin of the Atlantic, the summer isotherms run to the north-east: so do the storms. In winter the isotherms run south-eastward, and the storms turn in the same direction. Figs. 15 and 16, illustrating this change, are based on diagrams in the 'Laws of the winds,' by Ley, who first, some fifteen years ago, called attention to the control of rain over storm-tracks. It should be noted that the change in the

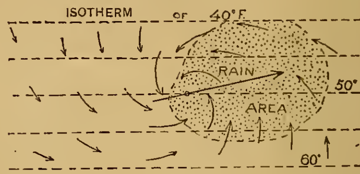


FIG. 14.

winter and summer prevalent winds would have a similar effect on the courses of European storms. In the United States, Professor Loomis has shown that the velocity, as well as the direction of advance, is closely dependent on the position and amount of the rain. In tropical storms the action of this cause of progression is not so clearly marked; for all the winds are moist, and almost equally warm. It is reported that the rainy area often extends farthest ahead of the storm; but it is not at once apparent why it should, for the front of the storm is occupied by winds from the north, which come from a slightly cooler latitude. It may be suggested, that, as their source in a region of high pressure (the 'horse latitudes') causes them to move faster, it also, probably, allows them a greater expansion and cooling, on entering the storm-area, than is permitted in the winds that come more slowly from the equatorial region of low pressure; but tropical storms probably de-

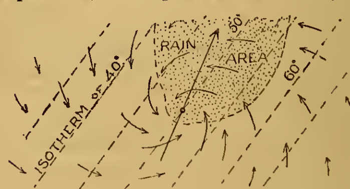


FIG. 15.

pend chiefly on the prevalent winds for their direction and rate of advance. In Austria none of the winds are very moist, and the rainy area has no definite relation to the advance of the

the surface. Observations on Mount Washington have shown the centre of low pressure there to be about two hundred miles behind that at sea-level (Loomis), and a similar retardation has been inferred in England from observations of cirrus-clouds (Ley). Fig. 12 shows this to be directly connected with rainfall; for, in this unsymmetrical storm, the former horizontal neutral plane is distorted, so that the centre of low pressure in the upper air is clearly behind, instead of vertically above, the centre on the surface of the earth.

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storm: hence here, also, other causes than rain determine the general easterly progression. Whatever effect rain would have is overcome by stronger causes. The separation of a cyclone into two independent storms is probably aided by the irregular distribution of rain.

Inequality in the strength of the inblowing winds is a result of irregular distribution of barometric pressure in the regions around the storm; and the stronger indraught will come from the higher pressure, because the gradients will be steepest on that side. Thus, in the case of the West India hurricanes, the higher pressure is to the north or north-east in the 'horse latitudes' above named, and the lower pressure to the south, near the equator; and the northerly winds will therefore be stronger than the southerly. The stronger the wind, the greater its centrifugal force;

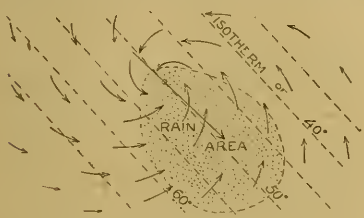


Fig. 16.

and, if this is not equal on all sides, the centre of lowest pressure will be drawn toward the point where it is strongest. This will be where it has to bend sharply around from its original direction, and may average about 135° from the source of the wind: hence, if the stronger wind come from the north-east, the storm-centre will move west: if from the east, north-west, as in fig. 17; and so on. Consequently, this cause will aid the first named in requiring the storm to describe a curved track in passing from the torrid to the temperate zone. It will also aid the coalescing of two neighboring storms, which has not unfrequently been observed; but, as a rule, it plays a subordinate part in determining the direction of advance. The slower advance of such of our storms as have extra strong winds on their western side (Loomis) is probably also due to this cause.

The fourth cause of a storm's advance is a peculiar effect of the deflective force arising from the earth's rotation. It has already been shown that this force increases toward the poles: it will therefore be greatest on the polar side of a cyclone; and the greater the

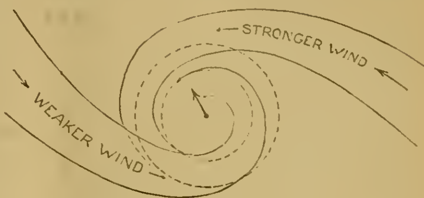


Fig. 17.

storm's diameter, the more marked the difference between the two sides. Its effect will be to make the centrifugal force on the two sides unequal, as in the previous cause; but the resultant motion will here be always from the equator. In the absence of other causes of motion, cyclones would therefore move along meridians: as it is, they nearly always have a more or less pronounced polar tendency, and their failure to move directly from the equator is due to the other causes of progression already mentioned.

(To be continued.)

A COMBINATION WALNUT.

A peculiar nut has recently been sent to me from Mr. S. L. Bingaman, Pughtown, Chester county, Penn. It was found on his lawn under a black-walnut tree (Juglans nigra). Mr. Bingaman says, "There is a pecan about sixty feet from it [the walnut-tree], and a shellbark some three hundred yards off." The nut is divided into two parts, as viewed upon the outside. There is a small portion at the base end, which has a covering similar to that of a black walnut. The upper and larger part of the nut has a covering closely resembling that of a shellbark (Carya alba). This exocarp is four-valved, and a partial separation has taken place at the upper end.

In its texture and adherence to the shell this covering is much like that of the ordinary black walnut. Upon cutting the nut in two, the shell (endocarp) is found thick, horny, and in all respects like that of J. nigra. The lower portion of the shell projects into the lower section of the nut, and resembles the point of a butternut. The engraving is from a carefully executed drawing, representing the nut of natural size.

The matter as above presented is left in the hands of those more familiar with subjects in teratology. There is no doubt that in the cross-fertilization of plants we may have a deviation from the parent form, even in the development of the seed thus fertilized, or in its surrounding parts. Some strawberry-growers are very careful what 'perfect' varieties are grown among their pistillate sorts to fertilize them. The fleshy receptacle, which is the edible portion of the strawberry, is more remote from the ovules which are fertilized on its surface than the covering of a shellbark or walnut is from the embryo within.

Hybridization between closely related genera is well established in several cases. Sachs mentions that it has been observed between species of Lychnis and Silene, Rhododendron and Azalea, Rhododendron and Rhodora, Azalea and Rhodora, Rhododendron and Kalmia, Aegilops and Triticum, and between Echinocactus, Cereus, and Phylocactus. The two genera Juglans and Carya compose a small order of closely related species. A study of the generic characters, as set down in the classification of these species, does not reveal any more striking difference than that shown in the exocarp. The male and female flowers are separated on the same tree (monoecious), and pollen must pass from flower to flower. This fertilizing-dust is produced in great abundance; and the distance between the black walnut and the pecan, or even the shellbark, is easily traversed by the pollen. There is probably no difficulty in the way of hybridizing from a difference of time in the flowering of the species. BYRON D. HALSTED.

New York, Oct. 26, 1883.

MANAYUNKIA SPECIOSA.

In a paper, illustrated with a plate, recently presented to the Academy of natural sciences of Philadelphia, Professor Joseph Leidy describes Manayunkia as a cephalobranchiate annelid living in fresh water, the only one of the order yet discovered not living in the ocean. It was found with the equally remarkable polyzoan Urnatella, with its tubes of mud attached to the same stones, in the Schuylkill River, at Philadelphia. It was first noticed, and a brief description given of it, in the Proceedings of the academy in 1858.

Manayunkia is nearly related to the marine genus Fabricia, with a species of which, described by Professor Verrill, the writer compared it, through specimens collected at Newport, R.I., and Gloucester, Mass. Manayunkia has not been observed elsewhere until recently, when it was found by Mr. Edward Potts, attached to a fragment of pine bark from Egg-Harbor River, New Jersey.

The tubes of Manayunkia are simple or compound, and in one instance five tubes branched and were pendent from a common stock in a candelabra-like manner. The little worm is very active and sensitive, and on the slightest disturbance withdraws into its tube. When quiet it protrudes its head, and spreads its cephalic tentacles or branchiae. The mature worm is three or four millimetres long, and is divided into twelve segments, including the head. The color is olive-greenish, due to the bright green blood circulating in the vessels of the animal. The head is furnished with a pair of conspicuous eyes, and supports a lateral pair of lophophores, each provided with sixteen cylindrical tentacles, invested with actively moving cilia, and closely resembling those of the polyzoa. The segments succeeding the head are provided with lateral fascicles of locomotive setae, and in addition, except the first one, are further provided with fascicles of pedal hooks.

The seventh segment is much larger than any of the others, and further differs from them in being greatly expanded in front; so that it gave rise to the idea that the worm undergoes division, though the process was at no time observed. The intestine is quite simple. The chief portions of the vascular system consist in a vast sinus enclosing the intestinal canal, giving off lateral pairs of branches to the segments, and a large vessel which extends from each side of the head into one of the tentacles, which is larger than the others. The blood is bright green, and is observed to be incessantly pumped into and expelled from the larger pair of tentacles. Ovaries occupy the segments from the fourth to the sixth inclusive. Organs supposed to be the testes extend from within the head into the third segment.

Manayunkia lays its eggs and rears its young within its own tube. The young, measuring about three-fourths of a millimetre, had the body divided into nine segments, and each lophophore provided with four tentacles.

In the species of Fabricia of our coast the number of segments of the body is the same as in Manayunkia; but the lophophores supporting the tentacles, instead of being simple, are trilobed or trifurcate. Fabricia has eyes in the tail, or last segment, as well as in the head, which is not the case with Manayunkia.

DRAINAGE SYSTEM AND LOESS DISTRIBUTION OF EASTERN IOWA.

These are described by Mr. W. J. McGee in a recent communication to the Philosophical society of Washington. The Mississippi River, where it forms the eastern limit of Iowa, flows somewhat to the east of south, and then as much to the west of south, giving the boundary an eastward angle in its middle part. The general strike of the rocks in eastern Iowa is south-east; and the dip, which is gentle, is south-west. The broadest outcrops are those of the Niagara and Hamilton formations. The Niagara, having resisted the prequaternary planation, holds an escarpment, the crest of which runs from the extreme eastern point of the state to a point on the Minnesota line fifty miles west of the Mississippi. From this line there is a somewhat rapid descent to the Mississippi, and a gentle slope south-westward to the broad, shallow depression marking the position of the Hamilton. From this valley the ascent is gentle to the water-parting between the Mississippi and Missouri. The general slope of the region west of the Niagara escarpment, considered as a whole, is with the dip to the south-west.

Beside the south-east trending depression marking the Hamilton outcrop, there is a gently sloped and indefinitely outlined but continuous and actual prequaternary valley, extending southward across the eastward projection of the state, and traversing diagonally the upper Silurian, Devonian, and carboniferous rocks.

The north-eastern angle of the state, from the crest of the Niagara escarpment to the Mississippi, belongs to the driftless region. The remainder of the state is covered with drift, and is affected by the undulations characteristic of drift topography.

The general directions of the rivers are from north-west to south-east; but their upper courses swerve a little toward the meridian, and their lower are deflected slightly toward the east, so as to give them a gentle curvature with concavity to the north-east. There is, moreover, a convergence northward, as though they radiated from some point in Minnesota. The variations from this normal system are so few that the drainage is almost unique in its regularity. It is likewise independent of the general topography; for not only do the principal streams flow at right angles to the prevailing slope, and cut through the elevated escarpment when it lies in their way, but, with a single exception, they preserve their courses across the ancient north and south valley.

In their relations to minor topographic features, they conform to two antagonistic laws, — first, they follow in general the ill-defined shallow valleys which characterize the drift-plains; and, second, they flow for one-third of their total courses in narrow gorges, following the axes of a system of elongated ridges which constitute the leading features in the local topography. Moreover, they have in many instances gone out of their direct courses, and deserted valleys seemingly prepared for them, to attain the anomalous positions assumed under the second law of association; and in every such case the gorges have demonstrably been carved by the streams themselves. The avoided valleys are evidently pre-existent: they have not been appreciably eroded since the quaternary, and there has been no recent localized orographic movement.

So the drainage is essentially independent of the general topography, though affected by local topography; and its relations to local topography are largely anomalous.

The loess of the region is continuous stratigraphically, but follows different laws of distribution in different districts. It constitutes the surface throughout the driftless region, and at the margin it overlaps the drift. In the northern part of the drift-covered area it forms narrow bands with a general north-west trend, each of which caps a ridge. Farther south it covers the entire plain, eminences and depressions alike. In the driftless area it rests on and merges into a thin stratum of water-worn erratic material. In the belts traversing the contiguous drift-plain it passes downward into sand, which may, or may not, merge into drift. Elsewhere it reposes on the drift, into which it graduates insensibly. The ridges in which the rivers have carved their anomalous cañons are always loess-topped; and, wherever streams avoid low-lying valleys for high-lying plateaus, the plateaus are of loess exteriorly.

So in its distribution the loess of eastern Iowa is intimately connected with the driftless region, with the drainage, and with the topographic configuration.

In the communication referred to, Mr. McGee offers no explanation, but merely sets forth the facts. His working hypothesis has, however, been published in an earlier paper (*Amer. journ. sc.*, Sept., 1882), and may properly be restated in this connection.

It is now many years since Powell first proposed to class all inconsequent drainage as either antecedent or superimposed; and no later writer has added to the number of categories. In *inconsequent* drainage the courses of the streams are independent of the dip and other structure-elements of the rocks across which they run. If the drainage is older than the rock-structure, — if, for example, the dip has been given to the rock after the establishment of the stream-courses, — the drainage is said to be *antecedent*. If the drainage was established by the configuration of an overlying and unconformable formation, which has disappeared by denudation, the drainage is said to be *superimposed*. In eastern Iowa, the superficial formation being northern drift, which lies with little modification as originally deposited, the hypothesis of antecedent drainage appears quite out of the question, while that of superimposed drainage in the ordinary sense is equally inapplicable. Mr. McGee's working hypothesis is, that the drainage was superimposed in an extraordinary manner; namely, by the ice-sheet. This, he finds reason to believe, was so thin in that region as to have its superficial configuration materially modified by the small inequalities of its bed. Where the ice was retarded by ridges underneath, more time was allowed for superficial waste by melting: so that hollows were produced, and the rivers of the ice-surface came to be established over the ridges of the glacier bed. With the disappearance of the ice, they were stranded upon the hill-tops.

G. K. Gilbert.

LETTERS TO THE EDITOR.

The reefs, keys, and peninsula of Florida.

The recent appearance of the admirable memoir of A. Agassiz on the reefs of Florida, which I have read with intense pleasure, furnishes me a proper occasion for calling attention to my paper, published in 1857, 'On the agency of the Gulf Stream in the formation of the peninsula and keys of Florida,' [1] and especially to the fact that the most important results reached in that paper have been substantially confirmed by subsequent observations. These results are as follows: —

1. The reefs of Florida are unique, and therefore were formed under peculiar conditions, and therefore, also, require a peculiar explanation.
2. The continuous growth of land by coral agency, in the case of Florida, is also wholly unique, and obviously connected with the peculiar conditions under which the reefs were formed.
3. The main peculiar condition in this case was the formation and southward extension of a submarine bank upon which the corals grew in successive reefs.
4. This bank was due to the agency of the Gulf Stream.

In addition, I supposed that the bank was built up by mechanical sediments brought by the Gulf Stream mainly from the Gulf rivers. In this I may have been mistaken, although no other explanation was conceivable at that time. The recent examinations of the course of the Gulf Stream, which, it seems, does not sweep about the Gulf, as was formerly supposed, and examination of the nature of the material forming the Florida bank, render this view no longer probable.

A. Agassiz in his memoir accepts the progressively formed bank, and also that it is due to the agency of the Gulf Stream, but thinks that it is formed, not by *mechanical* sediments, but by *organic sediments*, partly *brought* by the Gulf Stream from other coral banks (e.g., the Yucatan bank), *but mainly* formed *in situ* by the growth of deep-sea animals; the Gulf Stream bringing, not the materials, but only the conditions of heat and abundant food necessary for rapid growth.

This is certainly a very important modification of my original view; but the fundamental ideas expressed in the above four propositions still remain.

I ought to add, that, following L. Agassiz, I had exaggerated the probable amount of land added to Florida by the combined agency of Gulf Stream and corals. The recent investigations of Smith [2] on the geology of Florida show that the process cannot have commenced farther north than the north shores of the Everglades. Joseph LeConte.

Berkeley, Cal., Nov. 24.

Musical sand.

In the early part of the summer of 1883, the writer, in company with several others, was sent from Wood's Holl to Monomoy Point, Mass., by Professor Baird, to look after a whale reported to have been stranded there. Wandering around the island, we found an extensive tract of sand, which, when rubbed under the feet, produced that peculiar singing sound so often heard by the writer upon the beach at Manchester, Mass. The singing portion seemed to be confined to a narrow strip several hundred yards long, between the very dry sand above high-water mark and the sand moistened by the tides. Knowing that the phenomenon was a rare one, specimens of the sand were obtained; but I am not able to tell where they are at present. Monomoy Point is a long, narrow, sandy piece of land projecting out from the south-eastern end of the base of Cape Cod towards Nantucket Island. It is composed entirely of sand; and the blowing of the particles, as also the force with which they are blown, were well illustrated by the fact that all the windows of the fishermen's huts were ground so perfectly that nothing was visible through them. We paid one fisherman to break a square of glass for us. It had been there sixteen years. Even in cases where new glass had been put in within two years, nothing was visible through the panes. At a distance of thirty feet from the house on all sides, sand was piled up nearly as high as the tops of the cabins. The lighthouse-keeper upon the island would undoubtedly obtain specimens of the sand; the strip being found near the place where the whale lay, — in fact, just a few feet inland from it. The writer will be glad to give any further information desired upon the subject.

R. S. Tarr.

Smithsonian institution, Dec. 4, 1883.

[1] *Amer. journ. sc.*, Jan., 1857. [2] *Ibid.*, 1881.

Rings of Saturn.

Apropos of the abstract on the 'Rings of Saturn,' published in Science for Nov. 16 (p. 660), it appears that Professor Alexander Winchell of the University of Michigan, in his work entitled 'World-life,' assumed and explained the gradual descent of the matter of the rings toward the planet, and also denied that the period of the inner satellite of Mars furnishes any objection to the nebular theory. The ultimate result of solar tides on the rotations of the planets is also referred to in the same work, though this has, I believe, long been an accepted conclusion by leading physical astronomers. W. B. T.

ARCHEOLOGY IN PORTUGAL.

Études préhistoriques en Portugal. Notice sur quelques stations et monuments préhistoriques. Mémoire présenté à l'académie royale des sciences de Lisbonne. Par Carlos Ribeiro, chef de la section des travaux géologiques, etc. Lisbonne, *Imprimerie de l'académie des sciences*, 1880. 88 p., 7 pl., and numerous engravings in the text. 4°. [Also in Portuguese.]

This publication, which has only recently been received by us, is the second instalment of a work the first of which appeared in 1878 (72 p., 21 pl.). We will accordingly give a brief account of the contents of both parts. Contrary to our expectations, we find in them no discussion of the important question of the alleged discovery of traces of the tertiary man in the valley of the Tagus; neither do they deal with quaternary times. They contain simply detailed accounts, with ample illustrations, of various discoveries, all belonging to the age of polished stone, made by the author in several localities in the immediate neighborhood of Lisbon, which are all laid down upon an accompanying map drawn to a large scale. The completed work will comprise six sections, three of which are contained in the two portions already published. Of these, the first describes the station of Licea, and the second, the megalithic monuments near Bellas; both of which places lie a short distance west of Lisbon. The latter also contains an account of the prehistoric remains at the Serra de Cintra, several miles farther west.

Licea is a little hamlet built upon the projection of an elevated plateau, of which two of the sides are naturally defended by deep ravines. In this respect it resembles other sites of human habitation in the age of polished stone, which were usually placed upon commanding positions, easily defensible, and having plenty of water. This naturally strong position was rendered more secure by having its sides sharply scarped in some parts; while in others, not so protected, there can still be seen remains of a wall built of huge unhewn stones. The whole area was thus converted into an intrenched camp of an oval shape, nearly half a mile long by half as broad. Within this space, excavations have brought to light various objects of the usual types belonging to the industry of the age of polished stone. There were numerous celts made of diorite or of basalt, some finely polished, well shaped, and with sharp cutting-edges, while others were of a ruder fabric; and also several hammer-stones. Knives, flakes, scrapers, arrow-heads, and lance-points abounded, made of different varieties of flint, many of which must have been brought from long distances. Rude clay vases, hand-made, and some of a large size, all baked in an open fire, together with a few bone implements, complete the catalogue of objects found. Associated with these relics were the remains of shell-fish, and the bones of several species of animals common in neolithic stations, such as the horse, ox, stag, goat, pig, wolf, and hare. There was also discovered a sepulchral grotto containing bones belonging to nine individuals of both sexes, half at least of which were those of very young children. We have good reason to believe that other similar caverns have been either destroyed, or filled up with the rubbish of the chalk-quarries that have been extensively worked in this locality. In the absence of a perfect cranium, nothing more could be determined than that the type was brachycephalic. From the general result of all the discoveries, the conclusion seems warranted that Licea was the habitation of a large population during the neolithic period. Signor Ribeiro, however, brings forward certain arguments to prove the existence of a second prehistoric civilization upon this same spot, belonging to the period of transition between the age of polished stone and that of bronze. But we must confess ourselves unable to perceive their pertinency; neither can we agree with him in thinking that any of the implements discovered here have 'a striking paleolithic appearance.'

In the vicinity of Bellas there still exist megalithic monuments, consisting of a half-dozen ruined dolmens, in which but little of importance was discovered, owing to their having been visited by previous explorers: nevertheless, two or three singular objects were found in them, which will be described later. Hard by, however, at Monte Abrahão, there is a covered alley in an excellent state of preservation, which has yielded important results. It is composed of a polygonal chamber some ten feet in diameter, and a gallery twenty-four feet long by six wide, extending in an easterly direction. The walls of the chamber are constructed of eight large slabs of hard gray limestone, rough, and entirely unhewn, planted more or less upright, and projecting some nine feet above the surface of the soil. It is evident, however, from the inclination at which the largest stone is placed, that it was not intended to be roofed over by a similar slab after the usual method of constructing such monuments. There had first been made with infinite toil, by the help of fire, an excavation in the solid limestone strata of the whole size of the chamber; and in this the large slabs were set. Of those with which the gallery was originally constructed, only three now remain in place; but the rows of smaller stones, by which they had been supported, were discovered when the surface-soil was removed, so that there can be no mistake as to the existence and extent of the gallery. It is admitted that dolmens and covered alleys were erected to serve as burial-places of the men of the neolithic age: consequently we are not surprised that Signor Ribeiro found this monument to contain human remains; but the number of them was quite unusual, amounting to as many as eighty individuals. This can be accounted for by the fact that certain circumstances seem to indicate that some of the remains had been interred elsewhere before they were removed to this resting-place. They were found in the gallery, as well as in the chamber; and it seems reasonable to suppose that there had been successive burials at intervals of time, and consequent disturbances of the soil, which would account for the situation in which many of the bones were found. Their condition was such as to allow but few inferences to be drawn as to their ethnic relations, no whole cranium having been found: sufficient, however, remained of one, to show it to be dolichocephalic, and one of the jaw-bones was prognathic. In this interment, however, was one peculiarity which we have never seen noticed before. Over the whole interior, but particularly at the eastern extremity of the gallery, there was spread a layer of rounded pebbles, covering the human remains. They ranged in size from an almond to a large apple, and were mostly of quartzite, though many were of limestone, and several of basalt. Evidently they had been brought from the beds of neighboring brooks lying some three hundred feet or more below the level on which the monument stood. That they were not intended merely to protect the bodies from wild beasts was plain, from the fact that the adjacent soil was filled with angular fragments of various rocks equally well adapted for that purpose. Here we have evidently a funereal custom analogous to the heaping-up of cairns over the dead by many primitive races.

Numerous objects of great beauty and interest were found accompanying the skeletons. Among them were only four celts; but there were no less than one hundred and twenty flint arrow-heads, very many of them of the choicest workmanship, and including all the well-known types which are figured in excellent woodcuts. There were found two very fine specimens of flint lance-heads, or more probably daggers, more than six inches in length, and of exquisite workmanship; and more than thirty knives, ranging in length from five inches down. There were also scrapers, numerous flakes, and fragments of worked flint of various sorts. Our author devotes an entire plate to a delineation of some twenty little instruments, some of which he thinks were "designed for delicate work, such as *the surgical operation of circumcision* (?), *and trepanning*." Another of larger size, disk-shaped, and terminating in front in a little point, and capable of standing upright on its base, his imagination has magnified into 'an idol, or some sort of symbol.' To our more prosaic vision the 'surgical instruments' are only ordinary little stone implements, which in this case happen to be made of transparent quartz; while 'the idol' is merely a piercer for making holes in skins, such as we have often found in our Indian shell-heaps.

There were half a dozen objects of unusual character, which Signor Ribeiro designates as 'war-clubs,' and two others, which he thinks were 'badges of authority.' They are quite similar in appearance, are of cylindrical shape, and made of limestone; and the largest is about a foot in length, and nearly two inches in diameter. A few bone implements were found, among them a button of a conical shape, and pierced at the base with two converging holes. The pottery consisted only of portions of some half a dozen small, rude vases. Two ornaments were found of considerable size, celt-shaped, and made of thin plates of gray argillaceous schist. One face was smoothed, and decorated with figures made by scratching lines upon it in the triangular pattern known by the name of the 'dog-tooth;' and it was pierced with a hole for suspension. Besides these, two smaller heart-shaped pendants were found, and more than a hundred beads of various shapes and sizes, made of different green minerals, out of which the author has reconstructed several tasteful necklaces. Taking every thing into consideration, this covered alley may be said to be one of the richest ever discovered; and we feel grateful to the author for his careful study and faithful delineation of it.

We have already stated that two or three peculiar objects were obtained from some of the ruined dolmens. They are made of thin plates of argillaceous schist, about a foot in length, and some two inches broad, and are shaped somewhat like the curved blade of a sword, having the end rounded, and pierced on the back side with a hole for suspension. Both surfaces are smooth, and are decorated with varying patterns of 'dog-tooth' ornamentation. Two similar objects have been previously discovered in Portugal; but we are confident they have never been met with elsewhere, and their use is entirely unknown. The third object is a sort of stone hoe, according to our author's opinion, shaped very much like a human foot, and having the lower portion of the leg for the handle, the top of which is sharp enough to be used as a scraper. Objects similar to this have been discovered in a cave a short distance to the south.

The Serra (or mountain) of Cintra lies due west of Bellas, and somewhat more distant than the latter place is from Lisbon. It is the most picturesque of all the mountains in the vicinity, and attains an elevation of over fourteen hundred feet. At the very summit is an artificial excavation in the porphyritic and granitic rock, divided into two portions. The inner chamber is circular, with a diameter of twelve feet, and height of nine; the other is a kind of open vestibule about eighteen feet square; and the two are connected by a short covered corridor, while the interior of the whole monument is lined with a wall of rough stones. In it were found a flint knife, or saw (an elliptical shaped implement, toothed around its whole exterior), and a few worked flakes. Fragments of clay vases of various shapes and sizes abounded, many of them having a 'herring-bone' pattern of ornament incised upon them. All of these objects evidently belong to the neolithic period; and the monument itself resembles a sort of combination of the dolmen and the sepulchral grotto.

But a novelty among neolithic interments seems to have been discovered at Folha das Barradas, a short distance to the north-east. This is excavated in the natural soil, a white limestone and green marl, and has almost the shape of a covered alley, twelve yards long, extending east and west. The circular chamber at the west was divided by pieces of thin flagstone into partitions intended to contain human remains, of which as many as twelve were found, but in so bad a condition as to be useless for study.

Accompanying the remains were a flint poniard, two very fine lance-points of unusual size, and seven large knives; also a long cylindrical stone 'war-club,' similar to those previously described, but more handsomely ornamented, and two of the 'badges of authority.' A flat pendant, like those already spoken of, and fragments of a few rude clay vases, completed the funeral furniture. But it should be noted, that both in this sepulchre, and the one last described, there was found a large number of the same kind of rolled pebbles as those which occur so conspicuously in the covered alley of Monte Abrahão.

In concluding this brief account of Signor Ribeiro's interesting researches, we can only express the hope that his recent death, which all lovers of knowledge must deplore, may not deprive prehistoric students of the publication of the remainder of the work.

THEORETICAL METEOROLOGY.

Theoretische meteorologie. Ein versuch die erscheinungen des luftkreises auf grundgesetze zurückzuführen Von Albert R. v. Miller-Hauenfels. Wien, *Spielhagen & Schurich*, 1883. 130 p. 8°.

The past twenty years have witnessed a great advance in the science of meteorology, viewed from a theoretical stand-point. Previous to this period, the laws deduced were derived empirically from the observations made; and this is largely true at the present time. The attempts to place the science upon a firmer basis by building upon well-established physical laws, and deducing conclusions by strict mathematical processes, have met with decided success. But this branch of meteorology is yet largely undeveloped: consequently there is no treatise that covers the ground satisfactorily, and there is a large gap between deductive meteorology and the inductive conclusions upon which meteorological text-books are based. The mathematical papers are scattered in the volumes of scientific journals, or published in separate form. Even if they were collected together, and their contents condensed into one treatise, the result would be unsatisfactory. It would be found that a large majority of familiar phenomena are yet unaccounted for, and that many of the conclusions reached by theoretical methods cannot be used for further investigations, on account of assumptions made for the sake of simplifying the work, but which are unwarranted by observed facts. The hope of meteorology as an exact science, however, lies in the success which will attend these theoretical investigations in the future; and therefore any treatise devoted to this branch of the science is welcomed, however fragmentary it may seem to the reader.

The latest publication upon theoretical meteorology is this octavo of a hundred and thirty pages, by Professor Miller-Hauenfels of Graz. It is confessedly incomplete, but seems to be worthy of the attention of the student. As its title implies, it is an attempt to refer atmospheric phenomena to fundamental laws. The author is not a practical meteorologist, but a mathematician, who treats the phenomena discussed as mechanical problems as far as possible, holding that the first thing necessary is to establish the fundamental laws of meteorology, and afterwards to build upon this secure foundation. In the first section the laws of Mariotte and Gay-Lussac are treated, the method giving essentially the same result as that deduced by Rühlmann in his well-known barometric formula. Passing then to the movements of the atmosphere, the author discusses first its general movement, and then the laws of the winds, the latter subject occupying a large part of the treatise. The laws of ascending currents as developed by Hann are briefly referred to, and the laws of moist air-currents also discussed, the formulae for which are based upon Hildebrandsson's exposition of Dalton's law. The fundamental laws of thermodynamics are the basis of the discussion of the disturbances of density giving rise to winds. Numerous theorems are laid down in connection with the phenomena of the winds, and it is recognized that differences of temperature are the original cause of them. The diurnal change of the barometric pressure is explained in a manner not unlike that usually followed, and the belief is expressed that the moon has an effect upon the atmosphere which would appear by a proper tabulation of barometric observations.

The above summary is sufficient to give an idea of the scope of the work. It is introduced to the public by Dr. Julius Hann, who remarks, with regard to deductive investigations, "Even where results derived deductively find no immediate application in nature, since the actual conditions are never so simple as those which must furnish the basis of the conclusions reached, yet they are of great interest and value in advancing knowledge, since they increase our insight into the nature of phenomena, and open the path upon which, in the course of time, we shall attain to their complete understanding."

The execution of the author's design, however, is not wholly satisfactory. On account of the fragmentary nature of the work, it is often difficult to understand the bearing of the subjects discussed, or to see what use can be made of the formulae derived. It is also not always easy to follow the author in his argument, and consequently the general effect upon the reader is one of disappointment. The treatise does not merit the title which is given it, though it may furnish useful suggestions to those who are investigating the subjects which it discusses.

HISTORY OF LAND-HOLDING.

The early history of land-holding among the Germans. By Denman W. Ross. Boston, *Soule & Bugbee*, 1883. 8 + 274 p. 8°.

This work of Mr. Ross starts from the principle of individual ownership and isolated farmsteads, as the primitive usage of the Germanic nations. The evidence for this the author finds in the sixteenth chapter of the Germania of Tacitus, in which he explains the *vici* to be villages, not of free tribesmen, as is generally assumed, but of serfs. Of community of ownership he finds no evidence, either in Caesar or Tacitus. In the period of the barbarian laws, too, the facts which have usually been understood to point to common or collective ownership he explains as meaning *undivided* property. He has no difficulty in proving the general prevalence of the principle of individual ownership at this latter period, so far as the laws and other documents of the period afford any evidence. That ownership is common wherever it appears in these documents, is as a rule temporary, and subject to individual claims, seems also fully established. The gap in the evidence is as to the two or three centuries which intervened between Tacitus and the barbarian codes, — a gap which is of no importance, if his interpretation of Tacitus is correct, but which leaves room, if that interpretation be not accepted, for the development of free village-communities in this interval, which may then, in some cases, have survived to a later period, by the side of the system of individual ownership which we must accept as the prevalent one for this period.

After developing these general principles, Mr. Ross proceeds (p. 26) to show how the isolated household may, in the course of a few generations, have developed into a clan-village; here, again, into a community of ownership which is not really corporate in character, but is on its way to divided and individual ownership (p. 38). The rules and usages of the inheritance and transfer of land are described with great fulness, after which the usages which appear to tell in favor of an original collective ownership — the rights of *vicini* to exclude strangers, to purchase in preference to strangers, and to inherit in case of lack of heirs — are discussed. Certainly these usages, which, it must be admitted, may accompany a system of private ownership, are, nevertheless, most easily explained on the assumption of a *previous* condition of collective ownership. We cannot think the explanation given on p. 52 to be wholly satisfactory.

The breaking-up of the clan-system is next considered, this being effected especially by female inheritance, adoptions, and alienations. An important topic is the founding of free colonies, off-shoots of the clan-communities, but modelled upon the serf-communities; and their organization and management are described with great fulness and lucidity. The relation between these free villages and the serf-villages — clan-villages of proprietors and of tenants — is discussed; and there is much here that would apply equally well to the village-community theory. They are indeed essentially the same in character with those assumed by that theory, only that they are represented by Mr. Ross as a later outgrowth instead of a primitive organization. The essay (which occupies 109 pages) ends with some brief considerations upon immunity, primogeniture, etc. The conclusions of the essay are supported by a mass of 'Notes and references,' occupying about 130 pages, and containing copious extracts from documents. There is a full index. This book is every way a thorough piece of work, which certainly places the village-community theory upon the defensive, and overthrows a considerable part of its assumptions; and, apart from its controversial character, as a 'history of land-holding' it possesses the highest value.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Hyperelliptic integrals. — The full title of this paper by M. Staude is "Geometrische deutung der additionstheoreme der hyperelliptischen integrale und functionen erster ordnung im systeme der confocalen flächen zweiten grades." Only a brief notice of M. Staude's paper is possible in this place, although its importance makes it worthy of a much more extended one. The paper is divided into five chapters. In the first chapter the author considers the geometric significance of the symmetric algebraic functions of two independent variables, and the differentials of the integral functions of an hyperelliptic form (*gebilde*) of deficiency (*geschlecht*). The second chapter treats of the representation of the *gebilde* in systems of confocal surfaces by aid of hyperelliptic functions, and opens by the introduction of certain transcendental parameters in place of the usual elliptic co-ordinates. An expression is also given of the homogeneous point co-ordinates in space in terms of products of the double theta-functions, and also of homogeneous plane co-ordinates in space by aid of products of two double theta-functions. The third chapter is of particular interest from a purely geometrical point of view. In this the author considers the relations of the addition theorem for hyperelliptic integrals to systems of confocal surfaces, treating particularly the reduction of given sums of three integrals to sums of two integrals of the same kind. The fourth and fifth chapters have not yet appeared, but the author mentions their contents. Chapter four is to treat of the ray-systems of common tangents to two confocal surfaces; and chapter five is to be devoted to a geometrical interpretation of Abel's addition theorem, by aid of which the reduction of the sum of any four of the integrals in question to the sum of two integrals of the same kind is arrived at by a purely geometrical process. — (*Math. ann.*, xxii.) T. C. [471

Discontinuous groups of linear substitutions. — The complete title of M. Picard's paper is "Sur une classe de groupes discontinus de substitutions linéaires et sur les fonctions de deux variables indépendantes restant invariable par ces substitutions." The theory of the elliptic functions has given the first example of a uniform function of a variable which does not change for a group of an infinite number of linear non-permutable substitutions effected upon the variable. The modular functions, i.e., the functions arising from considering the modulus as given by the ratio of the two periods, was for the first considered by M. Hermite. M. Poincaré has treated in his theory of the Fuchsian functions, in all its generality, the subject of functions of one variable which are reproduced by a group of an infinite number of linear substitutions. M. Picard, in the present memoir, proposes to consider functions of *two* independent variables which may be considered as analogous to the elliptic modular functions. He shows, first, that the Abelian functions do not conduct to functions entirely analogous to the modular functions, and illustrates this by the Abelian functions of the first order. But by taking the case of the Abelian functions of the second order, i.e., of three variables, he has found an indication of the desired extension, and hopes in a future paper to enter more fully into the subject of functions of two variables which are analogous to the modular functions. The present paper is interesting as pointing out the difficulties, and indicating the manner of overcoming them, in an entirely new department of the theory of functions. — (*Acta math.*, i.) T. C. [472

PHYSICS.

Target-shooting. — From Liagre's theory that errors in target-shooting are compounded of errors in sighting and in levelling, each of which follow independently the law of error, it was shown by Mr. C. H. Kummell that shots of equal probability are arranged in ellipses, which can be reduced to circles of shots uniformly distributed, the integration being much simplified by using the reduced distances and directions. Sir J. Herschel's 'even-chance circle' (ellipse, more generally), the one hit or missed with equal probability, can be deduced from the shots actually found in any given circle (ellipse), the most reliable result being given by the one containing the greatest number of shots, whose radius (mean semi-diameter) is the *most probable* shot. The number of shots falling within this ellipse should be about thirty-nine and one-half per cent. The equations between the even-chance shot (ρ), the most probable shot (ε), and the average shot (r_0), are —

$$\rho = \varepsilon\sqrt{2\,l\,2}, \quad r_0 = \varepsilon\sqrt{\frac{\pi}{2}}.$$

In determining these from the sums of squares of the vertical and horizontal co-ordinates of the separate shots, the number that miss the target should be considered. The probable position of centre and axes should not be calculated from the observations, unless the true positions are unknown. A target of ninety shots at eight hundred yards' range, by the Irish team at Creedmoor in 1874, gave discrepancies of less than five per cent between observation and theory, in the number of shots within successive rings. One of fifty pistol-shots, at fifty yards' range, showed a similar agreement. — (*Phil. soc. Wash., math. sect.; meeting* Nov. 21.) [473

ENGINEERING.

Honigman's fireless locomotive. — Mr. Honigman constructs an engine in which the steam is supplied by evaporation from a charge of water which is furnished to the boiler at the station, and there brought up to the required temperature and pressure. The shell of the boiler is surrounded by, or may enclose, another vessel, between which and the boiler a narrow space is left, which is filled with caustic soda. The exhaust-steam is discharged into this mass of soda, which at once absorbs it; and the absorption gives rise to a large amount of heat, which is in turn given out, and returned to the water in the boiler, where it produces an additional quantity of steam; and the latter, being exhausted into the compartment containing soda, gives rise to additional quantities of heat; and thus the process is continuous, and the locomotive continues to exert its power, until the solution of soda becomes so far saturated that it can no longer take up the exhausted steam, and supply heat to the boiler, with sufficient rapidity to enable the engine to do its work. When this state of affairs is reached, the engine is recharged, and is again sent out on the line. The soda removed from the exhausted engine is placed in an evaporator and deprived of its moisture, and is then again ready for further service. This seems to be the first attempt to make practical application of the now well-known principle discovered by Faraday sixty years ago, and probably even earlier known on the continent of Europe. It is reported to be tolerably successful, and likely to have practical use where the presence of a fired engine is not permissible. — (*Lond. engineering*, Aug.) R. H. T. [474

Compound locomotives in Europe. — Mr. Borries has read a paper before the Union of German engineers, relating the progress of the compound engine on German railways. They were first introduced by A. Mallet of Paris. There are now forty of these engines at work. They are worked either simple or compound, as desired. They are economical, and may be worked with a wide variation in the amount of power developed, but are somewhat complicated, do not distribute the steam in the manner sometimes found practically desirable in working, and the action of the steam during compression leaves something still to be desired. Mr. Borries has endeavored to obtain a system which should permit the use of double expansion at all times, should be simple, and should permit the proper adjustment of the ratio of expansion at any time, if possible. At starting, steam is admitted to both cylinders, reaching the large engine-cylinder through a 'reducing-valve;' but, after starting, the machine works as a compound engine. At all points of cut-off, he gets nearly equal work done in each cylinder. The engine works easily, and no spark-arrester is needed. The excess of weight and cost is about four per cent above that of other engines: the gain in power is six per cent, and in economy of fuel nine and a half per cent. The engine is considered a success. The best results are reported from passenger-engines thus constructed. — (*Lond. engineering*, Aug.) R. H. T. [475

Finishing rails. — M. Gazan writes to *La métallurgie*, saying that the chemical composition of the steel has very little to do with the strength of the rail: it depends more upon the temperature at which the rail is finished in the mill. Those finished at a high red heat, and which are recognizable by their blue tint, are more brittle and weaker than those which are finished at a lower heat. The latter are usually covered with a reddish colored layer of oxide. In the former case the fracture exhibits a granular, and in the latter case a good steely, surface. M. Gazan thinks that, in the former case, time is allowed for the formation of crystals which cannot be produced in the latter. If the red-hot metal be worked until it has fallen below the red heat, it does not exhibit crystallization. — (*Railway rev.*, Sept. 8.) R. H. T. [476

Compound engines and boilers. — Mr. M. Coryell, a member of the U. S. naval advisory board, writes that good results have been obtained from recent compound engines. Pressures rarely exceed 100 pounds per square inch (8 atmos. nearly, absolute pressures); but he thinks 150 (11 atmos., absolute) can be carried by adopting, instead of the 'Scotch boiler,' a boiler of but 6 feet diameter (1.8 metres), with cylindrical shell and set in brick-work, — a plan of which great distrust has hitherto been felt by engineers. He suggests a still better scheme, however, — a water-tube 'sectional' boiler, safe for 200 pounds. This would permit fire-surfaces of but a quarter-inch (0.6 centimetre) iron. The use of fire-brick furnace-walls is found to give some economy of fuel. He has found high pressures and great expansion to give good results, and states that at least one successful designer would exceed 20 expansions, — a proposal which is not looked upon with favor by leading engineers. Mr. Coryell would use the beam-engine for screw-ships on account of its perfect balance. He states that engines of 6 feet stroke are in use, making 60 revolutions per minute with 60 pounds (5 atmos.) of steam and a cut-off at 5 inches (i.e., a ratio of expansion of 14.4), and that these engines have been in successful use for nine years, making voyages of five days without detention and with economy. Engines of 88 inches (2.235 metres) stroke have averaged 58, and have sometimes made 71, revolutions per minute. He thinks 4 feet (1.22 metres) the shortest advisable stroke for marine engines, and believes that twice that length will ultimately become common. — (*Mech. eng.*, Sept. 29.) R. H. T. [477

CHEMISTRY.

(General, physical, and inorganic.)

Active oxygen. — For the purpose of testing the accuracy of his conclusion relating to the action of moist phosphorus on carbonic oxide, which seemed to be disproved by the results of Remsen and Kaiser (SCIENCE, i. **704**), E. Baumann has repeated his experiments, using apparatus closed with glass stoppers, and taking every precaution to avoid contact of the gases with organic matter of any kind. In one experiment, seven hundred cubic centimetres of carbonic oxide, diluted with air, after passing through the apparatus, in fifteen hours gave 36.6 milligrams of carbonic dioxide, or 2.6 % of the carbonic oxide was converted into carbonic dioxide. In a second experiment, thirty litres of air containing 2.45 litres of carbonic oxide, when passed through the apparatus, in twelve hours gave 64.6 milligrams of carbonic dioxide, or 1.3 %. The temperature varied between 20° and 26°. Baumann found, further, that hydrogen peroxide was not produced when air was passed over palladium hydrogen, although carbonic oxide was oxidized to a small extent. He concludes, with Hoppe-Seyler, that this oxidation is due to the presence of oxygen in its active condition. — (*Berichte deutsch. chem. gesellsch.*, xvi. 2146.) C. F. M. 478

Determination of the atomic weight of antimony. — J. Bongartz prepared metallic antimony from antimonious chloride, which had previously been purified by six or eight fractional distillations. The metal was separated by electrolysis according to Classen's method, and it was converted into the sulphide by heating with potassic sulphide. Determinations of sulphur in the purified sulphide were made by Classen's method; viz., by oxidation with hydric peroxide, and weighing the sulphuric acid thus obtained as baric sulphate. The mean of twelve determinations gave 120.193. — (*Berichte deutsch. chem. gesellsch.*, xvi. 359.) C. F. M. [479

AGRICULTURE.

Conductivity of soils. — Wagner has made a somewhat extended investigation of the thermal conductivity of various constituents of soils and of the effect upon it of alterations in the structure of the soil and in its moisture. The materials used were quartz sand, kaoline, precipitated calcium carbonate, ferric hydrate, peat extracted with acid and alcohol, and artificial humus prepared from sugar. The quartz was found to be the best conductor, and the humus the poorest, while the other materials occupied intermediate positions. The differences were small, however, and of little significance, compared with those due to differences of texture, compactness, and moisture. Experiments with two natural (calcareous) soils showed that heat was transmitted more slowly in a loose soil than in the same soil compacted, and that these differences were greater the greater the water-content of the soil. The latter factor, indeed, seemed to have more influence than any other. Its effect is due, according to the author, to the fact that it is a somewhat better conductor than the air which it replaces in the interstices of the soil. The heat was transmitted horizontally, so that there was little chance for the transmission of heat by convection. The effect of compacting the material was also studied on the six soil-ingredients mentioned above; and the compacted material was found to transmit heat better than the loose, in every case except the humus, of which the reverse was true. The conductivity was found to increase with the size of the particles or aggregates of which the soil was composed. Observations were also made on the daily variations of temperature at different depths in sand, clay, and peat. The variations were greatest, and extended to the greatest depth, in the sand. The peat stood at the opposite extreme, and the clay between the two: in these respects, their positions corresponding to their relative conductivity as previously determined. — (*Forschr. agr. physik.*, vi. 1.) H. P. A. [480

GEOLOGY.

Lithology.

The Maine building-stones. — It is well known, that, at the time Dr. Hawes was attacked by the illness which terminated so fatally, he was engaged in the microscopic study of the United States building-stones. It has been hoped that some one would be able to take up his unfinished work, and, in justice to his memory, render him credit for all that he had done. Whether this desirable work will ever be accomplished is a problem for the future. Meanwhile, the Maine building-stones collected for Dr. Hawes's work have been the subject of a recent paper by Mr. G. P. Merrill. These rocks, together with much data relating to their use, etc., were collected by Mr. J. E. Wolff, now of the Northern transcontinental survey.

Mr. Merrill classes these building-stones under biotite granite, biotite muscovite granite, hornblende granite, hornblende biotite granite, biotite gneiss, biotite muscovite gneiss, diabase, olivine diabase, and argillite or slate. Of the eighty-three quarries in Maine in 1880–82, seventy-four are of granite or gneiss.

The granites vary in color from a light to dark gray, and from a light pink to red. In texture they vary from fine, even-grained rocks, to coarsely granular ones, containing orthoclase crystals an inch or more in length.

The constituents are quartz, orthoclase, plagioclase, biotite, or hornblende, with or without muscovite, apatite, magnetite, zircon, epidote, sphene, rutile microcline, and iron pyrites.

The paper is accompanied by descriptions of the microscopic characters of the granites, which are of value to all interested either in lithology or building-stones.

The gneisses are similar to the granite, and, so far as the present writer's observations have gone, they are of the same origin.

Diabase, under the name of black granite, is quarried at three localities in Maine, — Indian River in Addison, Addison Point, and Vinalhaven. The first locality produces a nearly black rock composed of plagioclase, augite, magnetite, apatite, and secondary hornblende and mica. The other localities produce a similar rock; with the addition of olivine and chlorite.

It is a remarkable freak of fashion which renders rocks of such undesirable composition so much sought for, and extensively used, for polished monumental and ornamental work used out of doors, for which they are entirely unfit. This well illustrates the wide-spread ignorance, even among architects, of the properties of building-stones, even if New York and Boston, coupled with Harvard university, did not furnish striking examples.

Mr. Merrill's remarks on the properties of building-stones need to be received with caution, especially those regarding some of the red granites of Maine; for he has probably never seen them after their polished surfaces have been long exposed to the weather. — (*Proc. U. S. nat. mus.*, vi. 165.) M. E. W. [481

MINERALOGY.

Cassiterite. — W. P. Blake notes the occurrence of cassiterite as stream-deposit, as well as in place in the Black Hills, Dakota. It occurs in a coarse crystalline granite, yielding sheets of mica of commercial value, and large cleavage blocks of felspar. In addition, spodumene is found abundantly in gigantic crystals. — (*Amer. journ. sc.*, Sept.) S. L. P. [482

Lithiophilite. — Two analyses of this manganese variety of triphilite are given by S. L. Penfield, — one from a new locality in Norway, Me.; the other from Branchville, Conn. The analyses fully substantiate the formula of the species $LiMnPO_4$, in which a part of the manganese has been replaced by iron. — (*Amer. journ. sc.*, Sept.) S. L. P. [483

Augite. — The calculation of several augite analyses is given by C. Doelter, in which he shows, that in addition to the usual meta-silicate, $R''_2Si_2O_6$, the alumina and alkali, when present in various amounts, are united in molecules of the general formula, $R''R'''_2SiO_6$, of which he recognizes the following distinct molecules, which are isomorphous with each other and with the meta-silicate $R''_2Si_2O_6$: —

$MgAl_2SiO_6$	$MgFe'''_2SiO_6$
$Fe''Al_2SiO_6$	$Fe''Fe'''_2SiO_6$
$CaAl_2SiO_6$	$CaFe'''_2SiO_6$
$Na_2Al_2SiO_6$	$Na_2Fe'''_2SiO_6$

(*Min. petr. mitth.*, v. 224.) S. L. P. [484

BOTANY.

Hybridization of Zea. — Dr. Sturtevant writes, concerning the supposed direct manifestation of hybridization in the fruit of the first year, "We have as yet no station data whereby this belief can be verified." — (*Rep. N. Y. exper. stat.*, i. 1883.) W. T. [485

Fed and unfed sundews. — Büsgen briefly reviews the experimental efforts thus far made to determine the value of animal food for carnivorous plants, and gives the results of some feeding-experiments with Drosera rotundifolia carried on by himself at Strassburg.

To avoid the inequality certain to exist in plants gathered from their native habitat, containing unequal quantities of reserve material, and of different ages, Büsgen used seedlings, arguing that the slight weight (.02 mgm.) of the seed, and especially of its nutrient contents, renders the dry weight of all plants essentially equal at the beginning of the experiment. By averaging the results obtained from many plants, individual peculiarities could be eliminated for the most part; and, by subjecting the seedlings to fluid-cultures with different fluids, the necessity of nitrogenous compounds in the water absorbed by the roots was susceptible of determination.

All of these possibilities were not realized in the experiments reported, which extended through two seasons, since comparatively few plants were experimented upon, and these were cultivated on cakes of peat of unknown composition, saturated with the culture-fluid used. The results were measured by the size and vigor of the grown plants, their fruitfulness, and, finally, the dry weight of all their parts.

Without giving the details of the experiments, — which, though not perfect, appear to be the most satisfactory yet performed, — we may state that they seem to show quite conclusively that plants of this species, properly fed with animal matter (aphides) through their leaves, are individually stronger, more fruitful, and of greater weight, than those subjected to the same conditions but unfed; thus corroborating the conclusions of Francis Darwin, Rees and Kellermann and v. Raumer. It seems, however, as if the organic nitrogen cannot wholly replace that derived normally through the roots, but appears as useful for the plant only when supported by a certain quantity of nitrogenous salts (cf. Liebig, 'Die chem. in ihrer anwend. auf agric. u. physiol.,' i. 436). — (*Bot. zeitung*, nos. 35, 36.) W. T. [486

ZOÖLOGY.

Animal chlorophyll. — Th. W. Engelmann maintains that the diffuse green observed by him in certain Vorticellas is genuine chlorophyll, and not due to the presence of any vegetable matter. The species was found near Utrecht, and is related to V. campanula. The green coloring is diffuse, but is restricted to the ectoplasm. To study it, Engelmann employed the bacteria method, and found that the bacteria accumulated about the animalcule; whence he concludes that the green produces oxygen. Examined with the microspectroscope, the activity of the green Vorticella, as measured by the gathering of bacteria about it, varies in the same way, according to the wave-length of the light in which the animal lies, as does the activity of vegetable chlorophyll under corresponding circumstances. From these and other observations, Engelmann deduces the existence of true living chlorophyll, not of vegetable origin in this protozoon. The article is a contribution to the controversy concerning the existence at all of animal chlorophyll. [Engelmann relies upon the distribution of bacteria in the field of the microscope as a test for the distribution of oxygen. It is obviously hazardous to assign to living organisms whose peculiarities are most imperfectly known the value of a specific chemical test. We must look upon the 'bacteria method' with suspicion, because the idea, which is very ingenious, does not rest upon an established certainty. (*Rep.*)] — (*Pflüger's arch. physiol.*, xxxii. 80.) C. S. M. [487

Morphology of the primitive streak. — Repiachoff has confused the primitive mouth (urmund) with the blastopore. Owing to this, he attempts to disprove the connection of the primitive streak and groove with the primitive mouth by insisting upon the well-established point, that the blastopore is connected only with the posterior end of the primitive groove, overlooking the fact that the blastopore corresponds only to the posterior part of the primitive mouth, the edges of which unite all the way in front of the blastopore to make the primitive streak and groove, if the latter is present. There appears to be a wide-spread difficulty in comprehending the concrescence of the edges of the primitive mouth to form the axis of the vertebrate body. — (*Zool. anz.*, vi. 365.) C. S. M. [488

Coelenterates.

The life-history of American medusae. — Although Turritopsis is one of our most interesting hydromedusae, its metamorphosis has been entirely unknown. Brooks has added to McCrady's graphic description of the adult an account of the larva and of the changes through which the young medusa passes. The larva is very similar to Tubiclava Allman; and the medusa buds are carried upon short stems which grow out from the main stem, just below the hydranth. When set free, the medusa has eight tentacles and a short simple proboscis; but the endoderm-cells of the radial canals soon become thickened to form the great cellular peduncle, which is the most characteristic mark of the genus. Adult specimens of Turritopsis often contain the singular Cunina larvae which were discovered in this situation by McCrady.

Nemopsis Bachei is another very common medusa, the young stages of which have hitherto escaped observation. Brooks has reared it from a Bouganvilleia, and has traced the metamorphosis of the medusa.

Phortis gibbosa McCr. has been reared from a very singular campanularian hydroid which was washed ashore in great abundance at Fort Macon, on denuded Aglaophenia stems. Only one medusa escapes at a time, and this soon becomes larger than the entire gonotheca. The order in which the tentacles appear is shown in the following diagram.

The larva of Amphinema apicatum Haeckel is a Perigonomus, which grows upon the sand-tubes of Sabellaria. When set free, the medusa has no trace of the apical process, which is an adult feature, although it has usually been regarded as a larval characteristic. When five days old, the medusa begins to assume the adult form: the apical process is developed, the umbrella becomes like that of the adult, the oral folds appear, and the upper end of the proboscis becomes enlarged. — (*Stud. biol. lab. Johns Hopk. univ.*, ii. 465.) W. K. B. [489

Mollusks.

Extramarine mollusca of New Guinea. — Tapparone Canefri has undertaken a general work on the mollusca of New Guinea, of which the first part has just appeared in the shape of a fine octavo volume of three hundred pages and eleven plates. In proof-reading, typography, and illustrations, it presents a marked and favorable contrast to many Italian scientific publications. The second volume will contain the marine mollusks: the others find a place here. From such a region many novelties might be expected. The author, however, is conservative; and the divisions newly proposed are not numerous, though a considerable number of new species are described and illustrated. Bellardiella (Martensiana) from Port Dorey is a Pupinella in which the peristomal sulcus is replaced by a tube posteriorly directed, behind the lip. Sulcobasis and Cristigibba are sections of Helix, typified by H. sulcosa Pfr. and H. tortilabia Less. respectively. Cyclotropis (papuana) differs from Assiminea by its perforated base. Physastra resembles a thick-shelled reversed Limnaea with a dehiscent epidermis. We doubt if it should be referred to the Physidae. Lastly, the section Microdontia is proposed as a section of Unionidae for U. anodontaeformis, in which the anterior cardinal teeth are thin, compressed, and nearly parallel with the margin.

Besides full descriptions or synonymy of species, the work contains useful tables showing the exact distribution of each species and group of species, as far as known, and also dissections of the generative organs, and illustrations of the dentition of a number of species. The work will also appear as volume xix. of the Annals of the Museo civico of Genoa, and is provided with a good index. — W. H. D. [490

Structure of the oyster-shell. — Observations by Osborne show that the shell is formed by the crystallization of lime in the conchioline (not, as stated, chitinous) layer, as is generally believed. The structure of other species was found less easy of investigation; and the complexity of structure in many molluscan shells would indicate that the process of formation is not universally the same. — (*Stud. biol. lab. Johns Hopk. univ.*, ii. 4.) W. H. D. [491

Slime-spinning by Arion hortensis. — Mr. Roeback, having received a specimen an inch long, observed it crawling on a flat paper-knife, from which it projected in a horizontal position into the air, with only the end of its tail touching the knife. Emitting a thread of slime, it hung by it to a distance of four inches; and when, on reaching a support, the thread was severed, it immediately shrank into a minute, scarcely visible point of slime. — (*Journ. conch.*, July, 1883.) W. H. D. [492

Insects.

Distribution of the occident ant. — Rev. Dr. H. C. McCook made a communication on the geographical distribution of the occident ant, Pogonomyrmex occidentalis. The specimens upon which the communication was based were collected by Prof. J. E. Todd in Dakota. He reports that the species is confined to the bottom-lands along the Missouri River, and has not pushed eastward through the territory. This corresponds remarkably with Dr. McCook's conclusion, both from his own observations and those made under his direction by Dr. Horace Griffith of

Marengo, Io., that this ant does not dwell east of the Missouri River, in Missouri, Iowa, and Minnesota; that it avoids eastern while abounding in western Nebraska; and that it is not found in Kansas farther east than Brookville, which is near the site reported by Prof. Todd. The structure of the ant-hills, and the harvesting habits of the species, were described. Mr. T. Meehan, to whom had been referred a small quantity of the *débris* collected from one of the nests by Prof. Todd, reported that there were no seeds among the pebbles, but that there were a number of calices, or undeveloped capsules, of a leguminous plant, Dalea alopecuroides, which is common on the plains. Dr. McCook had been puzzled to explain why such intelligent creatures should be detected in harvesting immature seeds, until, upon inquiry, he found that leguminous plants have a succession of flowers; so that there may be mature seeds and flowers on a plant at the same time. It is evident that the ants were not harvesting out of season, but were occasionally deceived, and cast out to the refuse-heap the calices that contained no edible seed. — (*Acad. nat. sc. Philad.; meeting* Nov. 21, 1883.) [493

Dipterous maggots in man. — Dr. Samuel Lockwood exhibited a full-grown dipterous larva taken from the inner ear of a man at Paterson, N.J., Aug. 30. There was a perforation of the membrana tympani. The man had suffered seven days from its presence. The grub had entered the outer ear, but eluded an attempt to extract it by re-entering the drum. Appearing again in the external ear, it was extracted with forceps, and kept alive for several days. He referred to certain papers read to the society (one in 1880, and a sequel in 1881), in which he described specimens of dipterous larvae passed by a man in large numbers, and which he determined to be larvae of Sarcophaga carnaria and Anthomyia canicularis, which had come of eating tainted cold meat and cold boiled cabbage. He had also shown a larva, which he could not determine, which had been vomited by a girl. The larva taken from the man's ear he had determined to be the viviparous flesh-fly, Sarcophaga carnaria, and thought that the man had eaten meat on which were the freshly laid larvae, which, being very small, might easily be unperceived. If the man had coughed during the eating, he might have thus thrown one of the larvæ against the entrance to the eustachian tube, and it could readily ascend the epithelial walls, feeding upon the mucus on its way. The larva had attained full growth, and, about to pupate, was restless to find a nidus: hence the good fortune of its twice entering the outer ear from the rent in the tympanum. Dr. A. V. N. Baldwin remarked that he had recently found a cluster of grubs, hard-packed, in the external ear of a man in Bellevue hospital; to which Dr. Lockwood replied, "Probably the parent fly had oviposited there when the man was asleep, attracted by the fetid odor of a diseased ear." — (*N. Jers. micr. soc.; meeting* Nov. 10.) [494

Spinning-habit of Psocus. — Rev. H. C. McCook announced that the small neuropterous insect, Psocus sexpunctatus, had recently been found, for the first time in America as far as he was informed, on the Wissahickon Creek, Fairmount Park, Philadelphia, by Mr. S. F. Aaron. The family of the Psocidae is of peculiar interest in being the only true insects which spin webs in the imago state. The generally larval function of web-spinning might, perhaps, be correlated with the rank which zoölogists assign the Neuroptera as the lowest in the order Insecta. It is, however, a striking example of the diverging and independent lines along which life-forms have sprung up in nature, that a function which belongs to the larval stage of insects, and which appears in the imago stage only in the lowest type of the same, should appear as the most permanent and characteristic function of the spider, — an animal, which, although it is now commonly given a lower place in the same subkingdom with the insect, is certainly very differently and but little less highly organized. It would be a difficult task to trace, or even imagine, any evolutionary connection between the web-spinning spider, the web-spinning lepidopterous larva, and the web-spinning neuropterous imago. There is, indeed, the common factor, the spinning-function; but the physiologist fails to perceive any use or combination of the same which can unite the organisms in which it inheres. — (*Acad. nat. sc. Philad.; meeting* Nov. 27.) [495

VERTEBRATES.

Action of the respiratory movements on circulation. — Taljanzeff states, that, in violent breathing, partial or complete inhibition of the contractions of the right side of the heart may take place, without, however, any fall of arterial pressure resulting; the blood being forced from the right to the left side of the heart by the action of the breathing-movements on the heart, especially on the right ventricle. He has discovered, also, that if the branches of the vagus going to the lungs are cut, and their central ends stimulated, a decided reflex action on the heart and blood-vessels is obtained. In most cases the heart was slowed, giving the well-known 'vagus pulse,' and the blood-pressure lowered; though in one experiment there was a fall of aortic pressure without any change in either the force or rate of the heart contractions. — (*Centralbl. med. wiss.*, 1883, 401.) W. H. H. [496

Vaso-motor nerves of the leg. — In a brief preliminary communication, Bowditch and Warren give some of the results of an investigation upon the vaso-motors of the extremities. Their method of determining the contraction or dilatation of the blood-vessels was to enclose the limb in a plethysmograph, — a method undoubtedly very delicate and accurate, but possessing the disadvantage that it gives only the general result of the stimulation of the nerve on the blood-vessels of the limb as a whole, and furnishes no indication of local dilatations or constrictions which may take place. They find that stimulation of the peripheral end of the divided sciatic may cause either constriction or dilatation. When the induction-shocks followed in rapid succession (16 to 64 in a second), a constriction of the blood-vessels was the general result. When the stimuli followed more slowly (4 – 0.2 in a second), a dilatation was produced. With a medium rapidity of stimulation, a contraction was observed in the beginning, followed by a dilatation. The latent period of vaso-constriction was estimated at 1.5″; that of vaso-dilatation, at 3.5″. The vaso-dilator effects continued for some time after the cessation of the stimulus. — (*Centr.-blatt. med. wiss.*, 1883, 513.) W. H. H. [497

Mammals.

Birth of a mandrill in captivity. — A mandrill was born in the Hamburg zoölogical garden in July, 1882. It lacked the brilliant coloring of the face characteristic of the adult, and had but weakly developed face-wrinkles. The countenance and posterior callosities were flesh-colored. Only the upper and posterior portion of the head and a space on the median line of the back were dark. — (*Zool. garten*, xxiv. 1883, 235.) F. W. T. [498

The circulation in the kidneys. — This paper by Cohnheim and Roy furnishes an extremely important and interesting addition to our knowledge of the physiology of the kidney, and will undoubtedly, with the future work that is promised on the subject, throw much light also on the etiology of some of the diseases of that organ. The method which they employed in their investigation cannot be thoroughly understood without reference to the plates which accompany the article. It is sufficient to say that the organ was enclosed in a sort of plethysmograph, to which Roy has given the name of oncometer, by means of which variations in volume of the kidney can be registered. With regard to the normal circulation in the kidneys, it was found that both the respiratory and pulse waves were shown in the kidney tracing, as well as the Traube-Hering waves, when these occurred.

Stimulation of the vaso-motor centre directly by means of dyspnoea, as well as stimulation of the central end of sensory nerves, caused a strong and rapid diminution in volume of the kidney, owing to the contraction of its vessels. This diminution in volume occurs when both splanchnics are cut; but in those cases in which they succeeded in severing the kidney from all external nervous influences, the kidney, instead of contracting, showed an increase in volume corresponding to the general rise of blood-pressure.

The influence of the splanchnics on the kidney circulation was especially studied. Section of the splanchnics caused no increase in the volume of the kidney, so that the tonic influence which these nerves have been supposed to exert on the kidney-vessels is rendered very doubtful, though the authors do not care to make any positive statement with regard to this point. Stimulation of either the central or peripheral end of the divided splanchnics gave a strong diminution in volume of the kidney. The fact, that, after section of both splanchnics, stimulation of the central end of a sensory nerve still causes a contraction of the kidney, shows that vaso-motor nerves pass to this organ by some other path. In order to cut off the kidney from all external nervous connection, it was necessary to divide not only the nerve-trunks in the hilus, but also to destroy the external coat (tunica adventitia) of the blood-vessels. In cases in which this was successfully accomplished, they could obtain no distinct evidence of a vaso-motor tonus of the kidney-vessels. Stimulation of the nerves of the hilus showed the presence only of vaso-constrictor and sensory nerves: in no case did they obtain any evidence of vaso-dilator nerves.

The circulations in the two organs are, to a great extent, independent of each other. Clamping the renal artery on one side has no effect at all on the circulation in the other kidney, and the same may be said with regard to the closure of other large arteries of the body. Throwing ice-cold water, or water heated to 50° C., on the whole of the skin surface of the animal, has little or no effect on the kidney circulation; a fact which seems to indicate that the direct connection between the functions of the skin and the kidney is not so close as has been supposed. A future paper on the influence of the composition of the blood on the circulation in the kidney is promised. — (*Virchow's archiv*, xcii. 424.) W. H. H. [499

ANTHROPOLOGY.

Ethnology of Yunnan and the Shan country. — Mr. Colquhoun has traversed the region lying between Canton and Rangoon, including Yunnan, the south-western province of China. The details of his exploration have been published in the *Proc. roy. geogr. soc.*, Dec., 1882, in a volume entitled 'Across Chrysee,' or will appear in a work now preparing on the Shan country. From Canton westward the people were pure Chinese; west of that, to the Yunnan frontier, the people were mixed on the rivers; and aboriginal races were found inland. Throughout Yunnan the chief population consisted of Shans disguised under a great variety of tribal names. Lolo and Miao-tzu, aborigines and Thibetans under the name of Kutsung, were seen. Mr. Keane, commenting upon this paper, said that amongst the Yunnan tribes were the widely dispersed Lolo people, who seem to extend in isolated groups from Szechuen, Kwei-chew, and Yunnan, down to the Tonquin highlands, and who by some travellers had been described as physically more like Europeans than Indo-Chinese. — (*Journ. anthrop. inst.*, xiii. 3.) J. W. P. [500

North-eastern Papua. — During a period of six years, 1875–81, Mr. Wilfred Powell made frequent visits to the eastern coast of New Guinea. Torres Straits has become famous as a pearl-fishing ground, worked by fleets of large boats built for the purpose, and manned by natives from all parts of Polynesia. The most fever-cursed portion of the island is the low alluvial plain skirting the Gulf of Papua, opposite Queensland. Here is found the only cannibalism known to the author to exist on the island. The whole of the population here are of a lower type than those in the more elevated districts to the east. At Brumer Islands the two races meet and intermingle, — the darker and more barbarous type of the Gulf of Papua and the south-west coast, and the lighter colored and better featured type, more resembling the Polynesian, inhabiting the south-east and the eastern peninsula. The last-mentioned people are numerous and industrious. The women are respected, and irrigation is carried on by means of bamboo pipes joined with gum. Obsidian is used for many purposes, such as shaving their heads and faces, carving wood, etc. — (*Proc. roy. geogr. soc.*, Sept.) J. W. P. [501

The Masai people in East Africa. — Zanzibar is now a commercial centre, dominated over by British interests and British trade. It is therefore a matter of great importance to establish an expeditious caravan route over the range in which are Mounts Kilimanjaro and Kenia to Lake Victoria. In the way of this route are the Masai, a tribe reputed to be savage and aggressive. Last autumn Mr. J. T. Last, a physician missionary, made a journey to the Masai country, and reports much that is interesting to the ethnologist as well as to the geographer. The Masai seem to belong to the great Galla race. The extent of their country is very large. The majority are of average height, and the women are about as tall as the men. There is a marked difference in features between the pure and the mixed Masai, the former being of a much higher type. The author describes the scanty dress of the men, one article of which is the *olding'ori*, a heart haped piece of goat-skin, serving more for a seat than covering. The women are completely clothed and extravagantly ornamented. There is no iron in their country, nor do they know how to work it. Their domestic animals, weapons, mythology, burials, marriage, crimes, polygamy, and modes of building are all fully described, and a copious vocabulary closes the paper. — (*Ibid.*) J. W. P. [502

Serpent venom. — The destruction of human life by the bites of poisonous serpents is so great in many countries, that it becomes really an anthropological problem to ascertain the amount of damage, and to seek the remedy. Dr. Robert Fletcher has brought together much information, and a great deal of the literature, in a paper read before the Washington philosophical society in May last. Sir Joseph Fayrer states the average mortality from serpent-bites in India to be fully 20,000 annually. In 1869 the returns were obtained through official sources, from a large part of India, with unusual care and accuracy. In a population of nearly 121,000,000, representing an area of less than half the peninsula of Hindostan, the deaths were 11,416, or nearly one in 10,000. Of these deaths, there were caused by

Cobra	2,690
Krait (Bungarus ceruleus)	359
Other snakes	839
Unknown snakes	6,922
No details	606
	11,416

In 1880, 212,776 poisonous snakes were killed and paid for; and in 1881, 254,968.

Even in Europe the number of accidents from snake-bite is very large. In one department of France, La Haute-Marne, the government paid, in six years, for the destruction of 17,415 vipers. — (*Amer. journ. med. sc.*, July.) J. W. P. [503

Mythologic parallels. — Gaidoz, commenting the tendency to trace the myths and folk-tales of Europe to the Aryans on the high plateaus of India, remarks, "that we cannot rest upon those eminences, but must prolong our inquiry over the whole earth: they are not Aryan, they are human." The discussion of resemblances in culture seems to land us ever in a double corner between the supposition that humanity reproduces ever the same phenomena under the same conditions, and the theory that similarity proves contact of some kind. M. Gaidoz cites two very interesting but far remote similarities. Among the ancient Romans, driving a nail was a religious practice, oft resorted to as a remedy against certain maladies, or a preservative against enchantments. Numerous references to this practice will be found under the word 'clavus,' by M. Siglio, in his 'Dictionnaire des antiquités grecques et latines,' p. 1240–1242; and in the chapter upon the nail in the *cella* of the temple of Jupiter, in Preller's 'Roemische mythologie,' 2d ed., p. 231. The law demanded that the rite (*clavi figendi causa*) should be performed by one high in authority, and, in cases of great public calamity, by the dictator himself. Now pass beyond the Pillars of Hercules to the mouth of the Kongo River, and listen to the words of Charles de Rouvre (*Bull. soc. géogr.*, Oct., 1880, p. 323): "Finally there are the *n'doké* fetishes, under the care of priests called *gangazambi*, who are reputed to have the power to cause to speak. An offering is made to the *n'doké* of one or more pieces of cloth and tafia. A nail is then driven into the image, while the *ganga* or the suppliant formulates his demand." 'The barbarians are older than we,' said Plato; and this form of nail-driving into the heart of the image, in order that our prayer may pierce the heart of the god, is much older than the Roman custom. M. Gaidoz further connects this custom with votives on oratorios, on trees, on church-walls, etc., for many purposes. In conclusion, the author insists that the beliefs of classic antiquity are to be studied not only in ancient texts, but in a past far more remote. — (*Rev. hist. relig.*, vii. 5.) J. W. P. [504

Hypertrichosis. — The development of hair on abnormal parts of the body has received the names Hypertrichosis universalis when it occurs over the whole body, and H. partialis when only over limited portions or in patches. The abnormality may be the period of development, in which case it would be heterochronic. It may be sex, as the beard of certain females, where it would be heterogenic. In the first case mentioned above it is heterotopic. Dr. J. G. Garson of London has collected photographs of distinguished cases of hypertrichosis, and states his conclusions as follows: "As to the cause of abnormal hair-growth, the atavistic theory seems to me to be the most probable explanation, as here we would not have to trace the atavus far back, and in the normal body we have the atavistic germ present, though in a rudimentary condition. It would, therefore, be what Gegenbauer terms a paleogenetic form of atavism. — (*Journ. anthrop. inst.*, xiii. 6.) J. W. P. [505

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Geology. — According to Prof. L. C. Johnson, who has been at work on the geology of Alabama (in the southern part of the state), the tertiary boundary will have to be moved from six to ten miles north of the limits usually assigned it on the maps. The lignitic, a sub-Claiborne division of the tertiary, will therefore appear much extended northward (ten miles at Allenton, six at Camden, and seventeen at Butler Springs). Professor Johnson has collections of fossils to prove his position. He has also recently investigated the boundary-line between the rotten-limestone group and the Eutaw group of the cretaceous, and between the latter and the older formations, and has made large and interesting collections of mammalian and saurian remains from the southern part of Alabama, principally from Autauga county.

Prof. R. D. Irving, who is devoting his attention to the copper-bearing rocks of Lake Superior, reports, that, in connection with Professor Winchell, he has personally examined the quartzites of Nicollet and Cottonwood counties, Minn. One hundred and forty thin sections of rocks have been made, mostly of Huronian quartzites; and more than half of these have been examined, with the result of proving that the quartzites of the original or typical Huronian of Lake Huron, and of the Huronian regions of Marquette and the Menominee River in Michigan and Wisconsin, are fragmental rocks, and that they have never undergone any metamorphism other than that involved in the deposit of interstitial quartz among the clastic grains, of which they are in the main composed. Professor Irving has also begun a comparative study of the greenstones, cherts and flints, and jaspery iron ores of the various Huronian regions examined by him.

Prof. T. C. Chamberlin, who has charge of the morainic investigations in the eastern United States, has recently examined the border of the later drift, principally in Indiana, and subordinately in Ohio, and has completed the tracing of the line from the Scioto to the Wabash, and more fully demonstrated the peculiar association of the remarkable bowlder-belts of those states with morainic aggregations. Prof. J. E. Todd, one of Professor Chamberlin's assistants, has determined more exactly the character of the morainic loop in the vicinity of Alexandria, in southern Dakota. He also found in that neighborhood an exposure of the Sioux quartzite with glacial striae, the direction of which is in harmony with the previous observations. Professor Todd also examined the drift-bluffs in the vicinity of the Big Sioux River, where the loess comes in contact with the drift. In October, Mr. R. D. Salisbury, who is also assisting Professor Chamberlin, made a detailed and specific study of the border of the driftless area in Wisconsin, Minnesota, and Iowa. This had heretofore been examined only cursorily by various observers; and Mr. Salisbury made a critical and connected examination, which developed some interesting points, one of which is to give the outline a form more in harmony with the moraines of the later epoch that lie opposite it on either hand.

Chemistry. — Mr. Hillebrand, the chemist in charge of the field-laboratory at Denver, has been investigating the so-called basic sulphates from Leadville. They are an important constituent of the ore deposits of that region, and occur as a rule under the ore bodies, seeming to be a product of secondary decomposition of the original sulphuretted ores. They appear to be a mixture of the mineral jarosite and basic sulphate of iron with hydrated arseniate of iron, anglesite, and pyromorphite.

A short time ago Prof. F. W. Clarke, chief chemist of the survey, visited and examined the Gilmore mica-mine in Montgomery county, Md., about twelve miles north of Washington, and found it of remarkable mineralogical interest.

Publications. — A few advance copies of the third annual report have been issued without the complete set of illustrations. Besides the report of the director and the various administrative reports, it contains the following papers: Birds with teeth, by Prof. O. C. Marsh; The copper-bearing rocks of Lake Superior, by Roland D. Irving; Sketch of the geological history of Lake Lahontan, by Israel C. Russell; Abstract of report on geology of the Eureka district, Nevada, by Arnold Hague; Preliminary paper on the terminal moraine of the second glacial epoch, by Thomas C. Chamberlin; A review of the non-marine fossil Mollusca of North America, by Dr. C. A. White.

A monograph on the geology of the region adjacent to Golden, Col., by Mr. C. Whitman Cross, is almost ready for the printer.

Geographical field-work. — The following notes of the geographic work of the survey during the season of 1883 are furnished by Mr. Henry Gannett, chief geographer.

Appalachian division. — In the southern Appalachians, five topographic and two triangulation parties have been at work during the season, and are now about returning to the office in Washington. Prof. W. C. Kerr has been in charge of the triangulation. The area embraced in the survey was the mountain region of North Carolina, exclusive of that worked in previous years; the northern half of the valley of east Tennessee; the south-western portion of Virginia; and that part of West Virginia lying between the Kanawha and Big Sandy rivers. In addition to the territory thus enumerated, the western part of Maryland, and adjacent portions of West Virginia and Virginia, were surveyed.

The total area thus comprised will be not less than twenty thousand square miles for the season. Work in this region is necessarily difficult and somewhat slow, on account of the scarcity of salient topographical points, the thick growth of timber, and the heavy rainfall. The latter is a fact that is ignored on most of the rain-charts published during the past ten years.

This work will be published on a scale of four miles to the inch, with contours two hundred feet apart vertically.

Massachusetts division. — In July a survey of Massachusetts was begun, under the direction of Prof. H. F. Walling. In this work the triangulation of the coast survey and the old Borden survey, and the topographical work of the past, are being utilized wherever practicable. The maps will be comparatively detailed, as the published scale is to be two miles to the inch. It is hoped that the work may be completed in about two years. Thus far, during the present season, about two thousand miles have been surveyed, work having been begun in the western part of the state, and extended eastward from the high country as cold weather began to come on.

Rocky-mountain division. — Mr. Anton Karl has surveyed part of the Elk Mountains in Colorado, extending the map made by Hayden in 1874, and has also been engaged in re-surveying the Maxwell grant in northern New Mexico for the interior department.

Wingate division. — This division, in charge of Prof. A. H. Thompson, has its headquarters at Fort Wingate, N.M., and has been working in the plateau country, principally in north-eastern Arizona. Field-work was begun early in May, and is now practically finished for the season. One triangulation party and three topographic parties have been at work, and have surveyed twenty-two thousand square miles. The region they covered is one of the most dreary and desolate within the limits of the United States; and, when its arid condition and the difficulties of transportation through it are considered, it will be seen that this division has accomplished a remarkable amount of work.

California division. — Mr. Gilbert Thompson, who is in charge of this division, began work last year in northern California, and completed the survey of about four thousand square miles. This year the work was extended in all directions from Mount Shasta, reaching to the Coast Range on the west, and into the lava-bed country on the east and south-east. This region lies between the parallels 38 and 42, and meridians 121 and 123. Although the atmosphere was smoky a large part of the time, this division has had a successful season.

Division of the Great basin. — The topographic surveys in the Great-basin district have been confined mainly to detailed work for special maps illustrating Mr. G. K. Gilbert's investigations of the lake-basins of this region. The principal work done has been the securing of notes for a map of the drainage area of Mono Lake, and for a number of special maps of ancient moraines.

Yellowstone-park division. — Mr. J. H. Renshawe has just come in from the field. He has been engaged in work for a detailed map of the Yellowstone national park. He began work early in June, and has covered fifteen hundred square miles, making plane-table sketches on a scale of two inches to the mile. He also remeasured, at Bozeman, a base-line laid out by Wheeler's survey in 1877. Mr. Renshawe expanded this base-line last season, but was prevented from remeasuring it then by the weather.

In California Mr. John D. Hoffman has been carrying on the survey of the quicksilver-mines steadily for more than a year.

NOTES AND NEWS.

Last summer, at the Zurich meeting of the standing committee of the International geological congress, Professor Neumayr of the Vienna university presented, by request, a plan for the preparation of a 'Nomenclator palaeontologicus,' to be issued under the auspices of the congress. His project was well received, and only awaits final indorsement at the meeting of the congress next year at Berlin. The scheme contemplates the appointment of an editor-in-chief (for which post no better person than Professor Neumayr himself could be selected); an editing committee, under whose general supervision the work will be carried on; national collaborators, who are to give special assistance in the literature of their own country; and special compilers, to each of whom a particular section of the work will be confided, and who will be placed in special relation with some one member of the editing committee.

The work, when completed, will probably consist of fourteen or more large octavo volumes. The mollusks are expected to require at least two volumes; one each will be given to cryptogams, phanerogams, protozoa, coelenterates, echinoderms, worms and molluscoida, arthropods, and vertebrates; two volumes will be given to a systematic enumerator, and one to an alphabetical register.

The nomenclator proper will consist of citations of all species (the nominal species in special type) published in scientific works, in accordance with recognized rules, with their synonymes; and the citations will include, *a*, the first publication; *b*, later descriptions which have really advanced the paleontological knowledge of the species, particularly such as give for the first time a satisfactory illustration; *c*, the illustrations found in the best known and most widely circulated 'fundamental work.'

Critical notes and newly proposed names will not be admitted, and conventional signs will be avoided. Abbreviations in the citations will be so given as to be readily understood by every one possessing some knowledge of the literature; and, for serial publications, the use of those employed in the Royal society's Catalogue of scientific papers is recommended. The geological horizon and geographical distribution will be indicated, the former according to the scale of the congress. The language employed will be Latin.

The plan, as presented by Professor Neumayr, is excellently conceived, and, if carried out in the same spirit, will be an immense boon to paleontologists. But one minor criticism occurs to us: it seems a pity to perpetuate the awkward abbreviations employed in the Royal society's Catalogue, in which are too frequently violated the two cardinal rules of proper abbreviations, — the preservation of the order of words in a title, and, in ordinary cases, the abbreviation of words before the vowel of the second syllable. If those in charge of the compilation of that magnificent but exasperatingly incomplete work had but taken counsel of some of their better trained brethren of the Index society, the world would have had more to thank them for. As it is, their shortcomings seem likely to breed perpetual sorrow.

—On the 28th of July, about nine o'clock in the morning, a Mr. Ferry started from Dover to cross the English Channel on a water tricycle. The construction of the machine is well shown in the accompanying illustration, which we take from *La Nature*. It is evident, however, that the displacement must have been much greater than that indicated. Instead of the light wheels of steel, with tires of rubber, of the land vehicle, there are bulky paddle-wheels. The small wheel behind serves as a rudder. Ferry arrived at Calais in less than eight hours. The distance as a bird flies is twenty miles, but on account of the currents the exertion required was considerably increased.

TRICYCLE ON WHICH MR. FERRY CROSSED THE ENGLISH CHANNEL.

—Mr. Boyd Dawkins, who has long been familiar to American archeologists through his cave explorations, and his volume on early man in Britain, discusses in the *North American review* the question of the antiquity of man in our own country. The subject is treated as a portion of one great problem common to the old and the new world, when man lived in the same low stage of culture on both sides of the Atlantic, at a time when the hands of the geological clock pointed to the same hour over the greater part of the world. With reference to the absolute chronology of geological phenomena, the author makes a statement worth preserving: "The present rate of the retrocession of the Falls of Niagara, or of the deposit of Nile mud, or of stalagmite in caverns, or of the accumulation of rocks themselves, or of the movement of glaciers, has been formerly used as a natural chronometer, on the assumption that they have been going on at the same rate throughout the past, and have been warranted never to stop, or to want winding up, or to go faster or slower than at the moment the observer was looking at them." The chronology adopted in the present paper is that of the author's 'Early man in Britain.' In the light of Dawkins's system, Professor Whitney's pliocene man is found wanting. Skulls of Mexican mustangs and modern stone implements are taken from the same layers. The human bones in the auriferous gravels are indistinguishable from those of the red Indians.

With reference to Dr. Abbott's Delaware River finds, the author remarks, "The identity of the implements proves that the river-drift hunter was in the same rude state of civilization in the old and the new world, while the hand of the geological clock pointed to the same hour." This river-drift man was unmistakably a man, and not a 'missing link.'

—From advanced sheets of the Proceedings of the Anthropological society of Washington, Col. F. A. Seely, of the U. S. patent office, publishes a pamphlet entitled 'An inquiry into the origin of invention.' The author is accustomed, day by day, as new claims for patents come before him, to eliminate the successive steps in the classes of machinery until he reaches the fundamental idea. This is the plan pursued in tracing backward the whole subject of invention to its sources in the mind of primitive man. The subject is illustrated, first, by the story of the steam-engine, and then by the examination of the bow and arrow and other implements of the lower races. The author rejects Professor Gaudry's Dryopithecus, and affirms, "Obviously, archeology can find no trace of a remoter age than that of stone; but I mistrust that the thoughtful anthropologist will accept the evidence of earlier ages, one of which, taking one of its perishable materials as the type of all, we may call the age of wood. Still farther back must lie an age, as indefinite in duration as any, when man existed in his rudest condition, without arts of any kind, except such as he employed in common with lower animals; and this is the true primitive period."

— In the Bulletin of the *Société géogr. de Marseille* for June, Heckel gives new information, with a *résumé* of old, in regard to the African nut known as Kola, or Guru. This seed, which is hardly to be called a nut, has a kernel about two inches in length, somewhat like that of a peanut, with a groove instead of a projecting point at the germinal end. It may be white or red, or both, to the number of four or five, in the same rough brown pod. It is the product of a tree of the family Sterculiacea. The genus has been called Sterculia, Kola, etc., and there are several species or varieties. This nut, or seed, is remarkable on account of containing (beside glucose, tannin, and a bitter principle) caffeine and theobromine in large proportion. Among the African tribes it takes the place of tea and coffee or cocoa, — products of plants belonging to very different groups, but valued for the same essential principle. It has been used from time immemorial, and many singular stories have been current as to its effect upon the system, though little authentic information was at hand.

Kola is gathered twice a year, carefully shelled, and the bare meats are immediately despatched into the interior, carefully wrapped in green leaves to insure them from drying. They have to be carefully picked over every twenty or thirty days, and all defective ones thrown out. It is considered very important that they should be kept fresh and somewhat moist. However, as soon as they begin to shrivel and dry up, the caravan merchants dry them thoroughly in the sun, and pound them to a powder in a mortar. The seeds are worth twenty or thirty cents a pound at the place where gathered, near Sierra Leone; but they rapidly increase in value away from the original market. At Goree a single seed will be sold at six to ten cents, according to the state of the market. In the interior the tribes on the Niger pay as high as one dollar per seed, and in times of scarcity a slave has been given for one seed. In the far interior the Arab merchants frequently dispose of the powder for its weight in gold-dust.

The Kola is the stimulant of the African tribes, and is in order on every occasion. Among those peoples where the nut is not indigenous, nor yet too extravagantly dear, no transaction of any moment can take place without an exchange of Kolas. This is either in token of good will or to 'bind the bargain.'

If two tribes ally themselves, they exchange white Kolas, this color being always the token of good will and peace. If war is declared, the announcement is made by sending red Kolas to the enemy. A request for a wife is accompanied by the present of a white Kola from the lover to the intended mother-in-law. The response favorable is by a seed of the same color; a refusal, by a red one. The wedding present of the husband to his bride is incomplete without a certain proportion of Kolas. In the interior, where they are so valuable, the gift of one is considered a high attention, and, when given by a chief to a white traveller, takes the character of an assurance of protection. One of the chiefs of the upper Niger sent Zweifel and Mousteir red Kolas wrapped in green leaves as a sign that they would not be permitted to ascend certain sacred water-courses included in their programme.

In religious and judicial proceedings they are equally important. All oaths are taken on these seeds: the witness holds his hand over them, swears, and then eats them. An accuser demanding justice brings to the judge a little basket of rice with four or five Kolas upon it. The sorcerers lay great stress on the attractive qualities of this seed in drawing away evil spirits, sickness, and misfortune. Friends place with the dead some Kolas, that he may safely endure his 'long journey;' and, to crown all, the Mahometans declare it to be a fruit of divine origin, brought to earth by the Prophet himself.

The nut is chewed as if it were tobacco; the powder is eaten. The taste is sweet, astringent, and bitter in succession. Europeans as well as negroes are devoted to it. It not only sustains the system under the greatest fatigues, even without food and for long periods, but it is also a certain preventive of the dysenteries and deadly fluxes which render that region so unhealthy. The powder makes foul water drinkable and harmless. The negroes, without sufficient cause, regard it as an aphrodisiac; and for this reason, in Martinique, in the botanical garden, where there is a plant brought from Africa, the director has never been able to save a single seed for propagation.

— Apropos to Professor Leidy's interesting article in No. 43, a correspondent draws our attention to the fact that the botanists have not overlooked the crystals in the bark of forest-trees. See, for example, Gray's Botanical text-book, from second to fifth editions, in which those in the bark of the locust-tree are mentioned, and those of hickory figured.

— Dr. A. Graham Bell has reprinted in pamphlet form, from the 'American annals of the deaf and dumb,' a very interesting account of the method followed by him in teaching a boy, deaf from his birth, to read the written language and to write English himself. The child was five years old when the course of instruction described began, and had received only three weeks' private instruction from the principal of the Boston school for the deaf and dumb. About a year later he was able to write a letter to his mother, which, to be sure, contains many mistakes, and is not always readily intelligible in its sentences, but which yet shows that he could already communicate with others in writing. The author gives specimens of such letters written without assistance. One cannot read these few pages without a strong feeling of admiration for the ingenuity and patience displayed in producing such a result, which shows how much can be done for the early education of the deaf and dumb.

— Mr. Estaban Duque Estrada, a native Cuban, has made an extended investigation of the useful qualities of the best Cuban woods, with a view to exhibiting the resources of his country in this direction, and to the opening of our markets to his native timber. The research was made in the mechanical laboratory of the department of engineering of the Stevens institute of technology, and included the determination of moduli of resistance in tension, torsion, and compression, as well as for transverse loading. The woods are specified by their Cuban and by their botanical names, and can thus be identified. The first part of the work is now published; and the moduli of elasticity found for forty woods of sixteen distinct species are given, together with a full description of the apparatus, and the methods of test. These moduli are all high, and run very uniformly, usually above two millions. But one (Caoba) falls under a million and a half. The stiffest woods are the Dagame (Colycophyllum candidissimum) and the Jiqui Comun (Bumelia nigra), which have a modulus of two millions and a half.

The woods described are nearly all hard, strong, heavy, highly colored, taking a handsome finish, and excellent for constructive purposes. Some of them are not liable either to decay, or to injury by insects. They seem quite likely, should they become known through Mr. Estrada's work, to prove exceedingly valuable additions to the stock of available woods for the American market; and their introduction is likely to afford a valuable commerce, if it is properly encouraged by our own consular department and the Cuban officials. A full account of this part of the investigation is given in *Van Nostrand's magazine* for November.

—The Johns Hopkins university circular for November announces the resignation of Professor Sylvester from the chair of mathematics, and his early return to Europe. His loss to this country will be keenly felt by our mathematicians, for his presence and activity have given mathematical studies a remarkable stimulus in this country. We notice, in the December number of the *American journal of mathematics*, so long conducted by Professor Sylvester, the name of Dr. Craig given as assistant editor, which we trust indicates that it will be continued by the latter after Professor Sylvester's departure. The Johns Hopkins university has recognized the value of Professor Sylvester's services by electing him *professor emeritus*, and by passing resolutions in which the board of trustees "cordially extend to him its hearty thanks for the invaluable services which he has rendered to the university, and also its profound sense of the great ability, the conscientious fidelity and untiring energy, with which he has discharged the arduous duties of his chair, thereby elevating the science of mathematics to its proper plane, not only in this institution, but in this country."

The circular also announces the acceptance by Dr. Paul Haupt, professor of Assyriology in the University of Göttingen, of a call to the Johns Hopkins university as professor of the Shemitic languages. Dr. Haupt has already commenced his work, and has classes organized in Hebrew, Arabic, Assyrian, Ethiopic, and Sumero-Accadian.

— Killingworth Hedges described to the British association the fire risks of electric lighting, and is thus reported in *Nature*. There is a great difference between the electric currents which have been in constant use for telegraphic purposes and those which are to be supplied by the undertakers under the Electric-lighting act. The latter can be said to be free from danger only when the heat generated by the current is utilized in its right place, and not developed in the conductors or wires which lead the electricity to the incandescent lamps. The Fire-risk committee have already issued rules for guidance of users of electric light. These can hardly be said to embrace all the salient points of the new subject, which can only be arrived at after years of practical work. The necessity of proper regulations has already been recognized by the insurance-offices, both in the United States and Germany; and some of their special rules are given in this paper. The conductors must be properly proportioned for the current they have to carry. Whatever resistance there is in the conductor will cause a corresponding development of heat, which will vary with the amount of electricity passing, and inversely as the sectional area. As the temperature in Dr. Matthiessen's experiments upon the subject was not increased over 100° C., the author has made some further experiments, heating the wires by the electric current from a secondary battery to within a few degrees of their melting-point. Various materials were tried; the wires and foils having such sectional area, and being so arranged, that, on the current being increased by twenty per cent, they were immediately fused. The total length of each experiment was twenty-four hours, during which time the current passing through varied slightly. The results of the experiments were given.

— Mr. Joseph Thacher Clarke is giving a course of three lectures on classical archeology before the Johns Hopkins university, in one of which the recent work at Assos, under his direction, will receive special attention.

— On Nov. 13 the Arlberg tunnel, the third largest not only in Europe but in the world, was opened. It was not exactly the formal opening which took place Nov. 13 (this was celebrated Nov. 20), but the sounding-rod (three metres long) of the powerful boring-machine penetrated from the west side to the east gallery. A mass of rock sixty centimetres thick still separated the two galleries. One gallery was driven from St. Anton, on the Tyrolese side, and the other gallery from Langen in Vorarlberg. Both galleries sloped upward into the mountain; the Tyrolese rising two feet in a thousand, the steeper Vorarlberg fifteen feet in a thousand. When the Tyrolese section had penetrated 4,102 metres, it was continued downwards at the grade of the eastern end, the point of intersection lying nearer the west than the east mouth of the tunnel. As with the St. Gothard tunnel, there was but one mistake in the measurement, the length of the tunnel being three metres less than was computed.

The construction of the tunnel (10,263 metres long was begun June 22, 1880, by hand, and Nov. 13 of the same year, machines were introduced; so that an opening was made just three years to a day from the first time that the point of the drill, driven by compressed air, was forced into the gneiss of the Arlberg. The laying of the road is to be completed in six months, so that business may be conducted about the middle of May.

The St. Gothard tunnel is 14,900 metres long. The boring in Airolo and Göschenen began in 1873. After seven and a half years' work, the last layer of rocks was broken through Feb. 29, 1880; and June 1, after nine years and a quarter consumed in its construction, the road was opened to commerce. The Mount Cenis tunnel (12,323 metres long) was built in fourteen years and a quarter.

With the completion of the Arlberg tunnel by the union of the Adriatic Sea and Europe's granary, Hungary, a further connection is established with the heart of the continent. The Arlberg road, therefore, has not only for Austria-Hungary, but more especially for Switzerland, great commercial and political significance.

— Dr. H. Newell Martin, of Johns Hopkins university, gave, in November, four lectures on the minds of animals, before the Peabody institute of Baltimore, covering the subjects of instinct and reason, the emotions and moral sense, in animals.

— *La Nature* presents an illustration of the new form of equatorially mounted telescope, lately set up at the observatory of Paris, in which the tube of the instrument is bent at right angles; one portion of it constituting the polar axis of its mounting, and the other moving thus in the plane of the equator. The rays of light from any celestial object are brought to the eye of the observer after reflection from two mirrors, the loss of light from which is said to be inappreciable. This form of mounting does away with the customary dome covering the equatorial; and the observatory may be said to consist of two parts, — the movable one, covering the object-glass end of the telescope; and the fixed part, that in which the observer sits and makes his observations, completely protected against the weather. The new instrument is the most powerful one at the Paris observatory, and was built by MM. Eichens and Gauthier, and the brothers Henry. The form of construction is due to M. Loewy, and it has been built through the liberality of M. Bischoffsheim.

— In a late number of *Naturen*, Dr. Geelmuyden has a paper entitled 'Om Islaendernes gamle kalendere,' or the ancient calendars of the Icelanders, the chief peculiarity of which lay in the regarding of the week as the unit of measurement of time. There was also a year of fifty-two weeks, or three hundred and sixty-four days, as also twelve months of thirty days each; the last of these coming in the summer, and having the *Sumar-auke*, or summer addition of the four extra days. The half-years were called *misseri*, and were more frequently employed as a measurement of time than the full year itself. About the year 1000, when Christianity was introduced into Iceland, the calendar of that nation was modified into a near approximation to the Julian calendar; and early in the year 1700 the new style of reckoning was adopted in Iceland, at the same time with Norway and Denmark.

— The following persons, formerly connected with Johns Hopkins university, have received recent appointments: Edward Barnes, professor of the higher mathematics in the Rose polytechnic institute, Terre Haute, Ind.; William C. Day, professor of chemistry and physics in St. John's college, Annapolis; George S. Ely, professor of mathematics in Buchtel college, Ohio; Kakichi Mitsukuri, professor of zoölogy in the University of Tokio, Japan; William A. Noyes, professor of chemistry in the University of Tennessee; and William T. Sedgwick, assistant professor of biology in the Massachusetts institute of technology, Boston. It is also stated by the *Nation* that Dr. C. S. Hastings has received the appointment to the chair of physics in the Sheffield scientific school of Yale college, New Haven.

— Dr. John Rae writes in the *Athenaeum*, "In the *Athenaeum* of the 28th of July there is an extract from a letter of Capt. H. P. Dawson, to the following effect: 'On inquiry, I find that all the far-off Indians describe stone pyramids or altars on the tops of some of the hills far to the north and east of this, . . . composed of blocks of roughly hewn stone of a size such that the men of these days cannot lift. . . . The Indians look upon these remains with great dread, and will not go near them.' I do sincerely hope that Capt. Dawson may discover something new on these reported monuments of 'roughly hewn stone;' but I fear they will be found to be the well-known work of the Eskimo, who, where the country is hilly and rocky, delight in putting up stones of very considerable size — although not larger than a few men can lift — in all sorts of picturesque forms, especially in the neighborhood of a favorite camping-place. An excellent illustration of these Eskimo constructions may be seen in the narrative of Sir George Back (facing p. 378), describing his descent of the Great Fish River in 1834. The Indians, unless they are in great numbers, have a very wholesome and wide-spread fear of the Eskimo, and therefore have a 'great dread of going near these remains,' thinking they might meet the people who built them."

— Professor William Trelease, of the University of Wisconsin, will give four lectures in January, upon the fertilization of flowers, before the Johns Hopkins university.

— It is stated in *Nature* that the meeting of the Linnean society of London for Dec. 6 was to be exclusively devoted to the reading of a posthumous essay on instinct, by the late Mr. Darwin. The essay was said to be full of important and hitherto unpublished matter with regard to the facts of animal instinct considered in the light of the theory of natural selection; and, as the existence of the essay has only now been divulged, this meeting of the Linnean society must have been of an unusually interesting character.

— Prof. S. P. Langley, of Allegheny observatory, will give six illustrated lectures next February, on the sun and stars, before the Peabody institute of Baltimore.

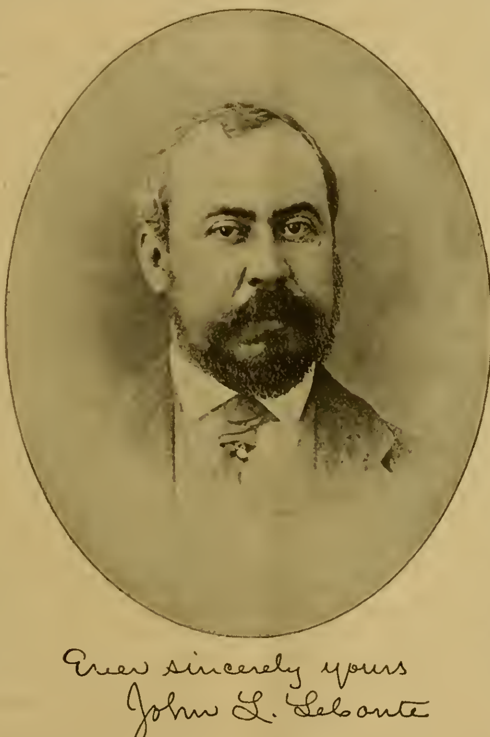
SCIENCE.

FRIDAY, DECEMBER 21, 1883.

JOHN LAWRENCE LECONTE.

American science has suffered a sad loss in the death of one of its best-known exponents. An advanced leader in his own department, profound and accurate in his labors, a cultured scholar, a genial companion and a true friend, — such a man was LeConte.

John L. LeConte, the son of Major John Eatton LeConte and Mary A. H. Lawrence, was born May 13, 1825, in New-York City. When but a few weeks old, his mother died, and the father thenceforward devoted himself to the care and development of his only child. The father died in 1860, having seen his son rise to a foremost place among the naturalists of his day.



On arriving at suitable age, he was placed in St. Mary's college, Maryland, from which he was graduated in 1842. The discipline of the school was severe, the training accurate and thorough. Early in his pupilage he exhibited decided tastes for natural-history studies outside of the scholastic course, greatly to the alarm of his tutors. The father, on being apprised of this, was greatly pleased, and directed that the tendencies should not be repressed, inasmuch as the boy exhibited no deficiency in his regular studies. His progress in the study of mathematics and languages was rapid and thorough, and doubtless laid the foundation for the accuracy and retentiveness of his memory, so marked in his maturer years. After the completion of the college course, he returned to his native city, and entered the College of physicians and surgeons of New York, receiving his medical degree in 1846.

For many years Major LeConte had been in correspondence with European entomologists, notably Dejean, and laid the foundation of the cabinet, now greatly enlarged, which made the basis of the future labors of the son. In 1844 the first essays of the latter in original work made their appearance, with unmistakable evidences of his youth and inexperience.

During 1849 he made several visits to the Lake-Superior region, once in company with Professor Agassiz, collecting largely, and publishing the results in Agassiz' work on that region. In the autumn of 1850 he visited California, remaining the greater portion of the following year, stopping for a while at Panama, collecting largely in many departments of natural history in a region in which nearly every thing was new to science, extending his explorations through the Colorado desert and as far east as the Pima villages. The material collected in these regions was carefully studied on his return, and the results published in the annals of the New-York lyceum. In 1852 the LeContes removed to Philadelphia, where the greater portion of the scientific labors of both have since been published. For a few months in 1857 LeConte accompanied the Honduras interoceanic survey, under the late J. C. Trautwine, publishing his observations in the report of that expedition. He visited at the same time the Fuente de Sangre, contributing an account of that phenomenon in Squier's 'Nicaragua.'

After these voyages, LeConte's scientific labor was uninterrupted until the breaking-out of the war. In 1862 he was appointed surgeon of volunteers, and shortly after made medical inspector with the rank of lieutenant-colonel; in which position he remained until 1865, exhibiting a capacity for organization and direction in a wider field than the cabinet to which he had hitherto confined himself.

During the summer of 1867 he acted as geologist of the survey for the extension of the Union Pacific railway southward to Fort Craig, under the command of Gen. W. W. Wright. His report, which in no way detracts from his reputation as an entomologist, was published as part of the report of the survey.

In the autumn of 1869 he started for Europe with his family, remaining abroad until near the close of 1872, visiting, in the mean time, Algiers and Egypt. His residence abroad interrupted somewhat his authorship, but not his studies. He visited all the accessible public and private museums; and his wonderful memory of the species of his own cabinet enabled him to settle many doubtful points of synonymy. Those who met him abroad were deeply impressed by his thorough scholarship, and his quick and accurate perception of the affinities of Coleoptera which he had never before seen. On his return he resumed his labors, which continued, with slight interruptions by ill health, until within a week of his death.

LeConte's career in science began in 1844 with his first paper in the proceedings of the Philadelphia academy, followed by others in other journals: these gave but little evidence of the future powers of the man, until, in 1850, his 'Monograph of Pselaphidae' appeared, in which an arrangement of these minute forms was proposed which remains at present the basis of the general classification of these insects. Shortly after appeared his 'Attempt to classify the longicorn Coleoptera of America, north of Mexico,' — a work of far wider application than indicated by its title, in which numerous suggestions of new characters and wider applications of old ones are found.

To follow his papers from this period would be a history of scientific coleopterology in America. Their importance and utility attracted attention abroad, and many were reprinted in whole or in part. As to their scope, they cover nearly every family in the order: and in every case his work is an improvement on what preceded it; he always left a subject better than he found it.

Several of his works require a special notice. His edition of the entomological writings of Say, in which he was assisted in their departments by Baron Osten-Sacken and Mr. P. R. Uhler, proved of inestimable value to students by placing within easy access the works of that pioneer of American science. The volumes appeared in 1859, have run through several editions, and are still in demand. Realizing that his favorite branch needed greater encouragement, he undertook, in 1860, the 'Classification of the Coleoptera of North America,' with the accompanying list of species, and descriptions of new forms. This work was never completed, but extended to the end of the Cerambycidae. The interruption of the work by the war made an interval of time in which the edition of the earlier-issued parts became exhausted, and, to a certain extent, antiquated from more recent studies. The results of this book are abundantly shown in the vast increase in the number of intelligent students and collectors, accompanied by a further demand for the exhausted edition, rendering a new one necessary.

Before the new edition could be prepared, it became imperative to study the Rhynchophora; and at this point LeConte made one of the boldest strokes of his career in the isolation of that series from other Coleoptera, and by proposing a classification of them as remarkable in novelty as it was true to nature. This was followed by the 'Species of Rhynchophora,' published as a separate volume by the American philosophical society.

The preparatory studies having been thus completed, LeConte looked forward with pleasure to an entirely new work to replace the old 'Classification,' and my co-operation was invited in the preparation of monographic essays. Two years ago, his health then slightly failing, he expressed the desire that the authorship of the new work should be equally divided; and in January, 1882, the work was begun. It was completed in March, 1883, in time for him to realize that it had been at least well received. To speak further of this work would, for obvious reasons, be inappropriate: suffice it to say, that his first edition made the ground-work of the second, and his spirit actuated the embellishment of the superstructure.

Since the completion of this work, his health has not admitted of much study; but he continued his work until within a few days of his death, and the incomplete manuscript will be published in the form he desired.

While LeConte's reputation will be based on his entomological writings, he by no means limited himself to this field. Mention has already been made of several important geological contributions. There are others of less moment. He has contributed a number of articles on vertebrate paleontology, and several on existing mammals. His 'Zoölogical notes of a visit to Panama' (*Proc. Philad. acad.*, 1852) illustrate the extent of his study in another direction. At least one article on purely social science has emanated from his pen.

In a general review of his writings, LeConte is found remarkably free from controversial tendencies. He gave to science the best results of his labor, knowing that what was worthy would in time be adopted. I know that he was better pleased to have errors of his own corrected than to correct those of another. He was above the limit of those petty jealousies which too often prevail between active workers in the same field. Those who sought his advice or assistance, either in person or by correspondence, were always made welcome; and the numerous cabinets determined by him gave evidence alike of his industry and liberality. The result of LeConte's labors has been the elevation of coleopterology in America from a traditional knowledge to a science with a permanent and distinctive literature.

LeConte was president of the American association for the advancement of science in 1874; and his address on retiring, regarding the relations of the geographical distribution of Coleoptera to paleontology, opened a new field for the thoughtful student.

No prominent public position was ever held by LeConte. He was urged by his friends for the position of commissioner of agriculture; and, while he received an indorsement of which any man might be proud, the choice of President Hayes gave it to another. That his eminence as a naturalist was recognized is shown in the numerous societies, at home and abroad, of which he was elected a member. Of the entomological societies of London, France, and Berlin, he was made an honorary member, — a distinction attainable by few, from the limited number allowed by the societies' rules. At the time of his death he was president of the American entomological society, and a vice-president of the American philosophical society.

In 1861 Dr. LeConte was married to Helen, daughter of the late Judge Grier, who, with two sons, survives him.

Dr. LeConte died Nov. 15, 1883, and was buried in West Laurel Hill cemetery, in the vicinity of Philadelphia. His death is an irreparable loss to American science, and a calamity in his special department.

George H. Horn.

THE WEATHER IN OCTOBER, 1883.

The monthly review of the U. S. signal-service gives in copious detail the weather conditions which prevailed in October. The peculiar features of the month were the deficiency in temperature and excess in rainfall in the greater part of the country. The former was most strongly marked in the Missouri valley and New England, the mean temperature falling below the average 3°.7 and 3°.6 respectively in these districts. In Tennessee, Florida, the Rio Grande valley, the South Atlantic and Gulf states, however, the mean temperature was from 2°.5 to 4°.3 above the average; so that the distribution of temperature was rather irregular. One instance of a maximum temperature of 100° was noted, while the frosts were frequent.

The distribution of rainfall is indicated by the following table: —

Average precipitation for October, 1883.

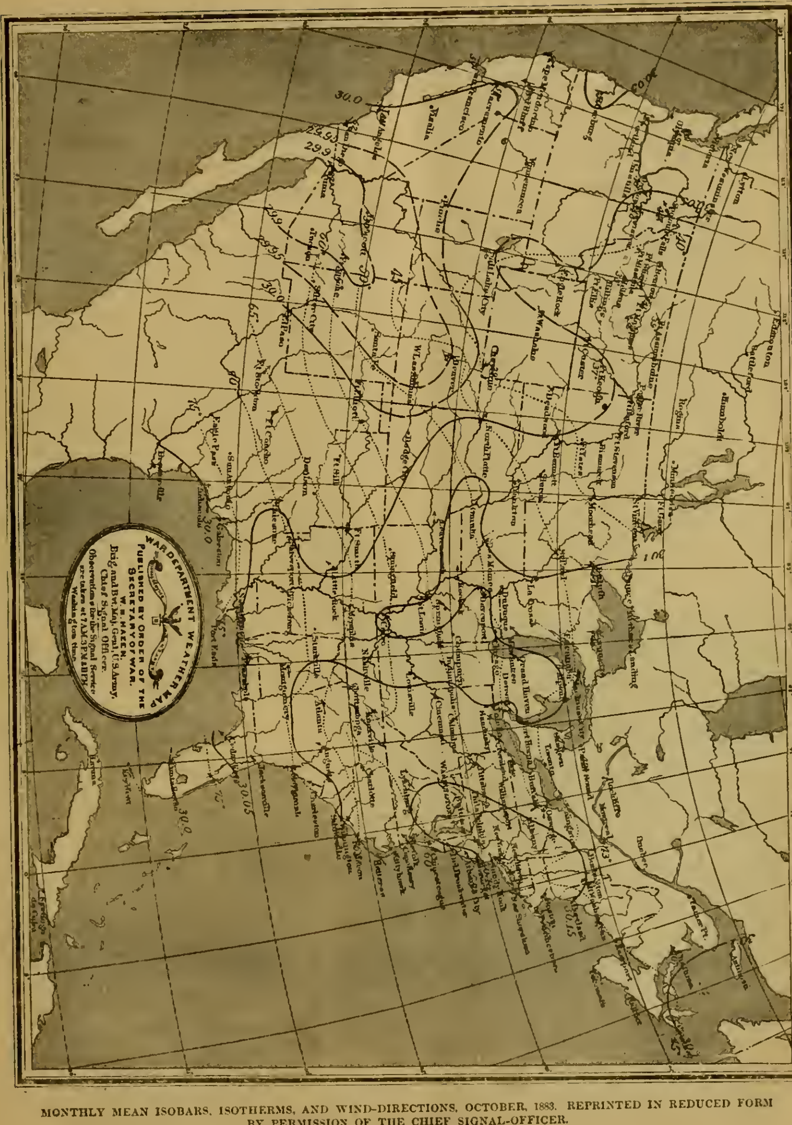
Districts.	Average for October. Signal-service observations.		Comparison of October, 1883, with the average for several years.
	For several years.	For 1883.	
	Inches.	Inches.	Inches.
New England	3.82	6.23	2.41 excess.
Middle Atlantic states .	3.07	5.13	2.06 excess.
South Atlantic states . .	4.77	3.14	1.63 deficiency.
Florida peninsula . . .	6.27	9.09	2.82 excess.
Eastern gulf	3.79	2.51	1.28 deficiency.
Western gulf	3.75	5.23	1.48 excess.
Rio Grande valley . . .	3.86	0.94	2.92 deficiency.
Tennessee	3.42	5.60	2.18 excess.
Ohio valley	3.04	6.75	3.71 excess.
Lower lakes	3.12	2.86	0.26 deficiency.
Upper lakes	3.80	3.62	0.18 deficiency.
Extreme north-west . .	2.01	2.93	0.92 excess.
Upper Mississippi valley,	3.19	4.82	1.63 excess.
Missouri valley	2.01	4.12	2.11 excess.
Northern slope	0.81	1.94	1.13 excess.
Middle slope	1.26	3.40	2.14 excess.
Southern slope	1.57	2.98	1.41 excess.
Northern plateau . . .	2.50	1.64	0.86 deficiency.
Southern plateau . . .	0.67	0.84	0.17 excess.
North Pacific coast. . .	4.45	3.49	0.96 deficiency.
Middle Pacific coast . .	1.11	1.71	0.60 excess.
South Pacific coast . . .	0.33	1.16	0.83 excess.

The drought in New England and in some portions of the Southern States was broken by the copious rains of the month, but still continued in other sections.

The storms of the month present some noticeable features. The weather over the North Atlantic Ocean was generally stormy, being attended by a succession of strong westerly breezes. There were seven depressions charted on the ocean, all of which moved in a north-easterly direction. Of these, four were continuations of storms in the United States, one of which moved to the British coast; and one was a tropical hurricane which gave evidence of its presence off the Atlantic coast by high winds at coast stations, and which moved north-eastward as far as the twentieth meridian. Nine depressions were charted in the United States; all, with one exception, moving north-easterly, and but one being a severe storm. This occurred on the 17th and 18th, causing violent gales on Lake Michigan, though few casualties were reported. One depression moved in quite an unusual path: it was reported at Yuma, Arizona, on the 2d, and moved in a northerly direction into British America. There is reason to believe that it was a tropical hurricane which crossed Mexico in the latter part of September from the Caribbean Sea, and, recurving in the Pacific, entered the country in Arizona as a weak depression. All of the tropical hurricanes of this season have run their courses mainly in the ocean. Though they have been fully as numerous and as severe as usual, their ravages have been confined to the islands in their path and to the vessels exposed to their fury.

Sunspots continue to be numerous. There was only one brilliant aurora in October, and this was observed principally in New England and northern New York. Severe shocks of earthquake were experienced in San Francisco on the 9th and 10th, causing considerable alarm, but no material damage. A new volcano has made its appearance, bursting out in Bering Sea: it has been exceedingly active, having already formed an island eight hundred to twelve hundred feet high. On the 20th a shower of mixed sand and water fell at Unalashka, sixty miles east of the volcano, which may have come from it.

The accompanying map represents the mean pressure, temperature, and wind-directions. The former is worthy of note because of the regular increase of pressure from west to east. Usually there are two high areas in October, — one near the eastern coast, and the other in the north-western territories. The latter was wanting in October of this year.



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, OCTOBER, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF THE CHIEF SIGNAL-OFFICER.

A NEW RULE FOR DIVISION IN ARITHMETIC.

THE ordinary process of long division is rather difficult, owing to the necessity of guessing at the successive figures which form the divisor. In case the repeating decimal expressing the *exact* quotient is required, the following method will be found convenient.

Rule for division.

First, Treat the divisor as follows: —

If its last figure is a 0, strike this off, and treat what is left as the divisor.

If its last figure is a 5, multiply the whole by 2, and treat the product as the divisor.

If its last figure is an even number, multiply the whole by 5, and treat the product as a divisor.

Repeat this treatment until these precepts cease to be applicable. Call the result the *prepared divisor*.

Second, From the prepared divisor cut off the last figure; and, if this be a 9, change it to a 1, or, if it be a 1, change it to a 9: otherwise keep it unchanged. Call this figure the *extraneous multiplier*.

Multiply the extraneous multiplier into the divisor thus truncated, and increase the product by 1, unless the extraneous multiplier be 7, when increase the product by 5. Call the result the *current multiplier*.

Third, Multiply together the extraneous multiplier and all the multipliers used in the process of obtaining the prepared divisor. Use the product to multiply the dividend, calling the result the *prepared dividend*.

Fourth, From the prepared dividend cut off the last figure, multiply this by the current multiplier, and add the product to the truncated dividend. Call the sum the *modified dividend*, and treat this in the same way. Continue this process until a modified dividend is reached which equals the original prepared dividend or some previous modified dividend; so that, were the process continued, the same figures would recur.

Fifth, Consider the series of last figures which have been successively cut off from the prepared dividend and from the modified dividends as constituting a number, the figure first cut off being in the units' place, the next in the tens' place, and so on. Call this the *first infinite number*, because its left-hand portion consists of a series of figures repeating itself indefinitely toward the left. Imagine another infinite number, identical with the first in the repeating part of the latter, but differing from this in that the same series is repeated uninterruptedly and indefinitely toward the right, into the decimal places.

Subtract the first infinite number from the second, and shift the decimal point as many places to the left as there were zeros dropped in the process of obtaining the prepared divisor.

The result is the quotient sought.

Examples.

1. The following is taken at random. Divide 1883 by 365.

First, The divisor, since it ends in 5, must be multiplied by 2, giving 730. Dropping the 0, we have 73 for the prepared divisor.

Second, The last figure of the prepared divisor being 3, this is the extraneous multiplier. Multiplying the truncated divisor, 7, by the extraneous multiplier, 3, and adding 1, we have 22 for the current multiplier.

Third, The dividend, 1883, has now to be multiplied by the product of 3, the extraneous multiplier, and 2, the multiplier used in preparing the divisor. The product, 11298, is the prepared dividend.

Fourth, From the prepared dividend, 11298, we cut off the last figure, 8, and multiply this by the current multiplier, 22. The product, 176, is added to the truncated dividend, 1129, and gives 1305 for the first modified divisor. The whole operation is shown thus: —

```
        1883
           6
       -----
       1129|8
        176
       ----
       130|5
       110
       ---
        2|40
       88
       |90
     -----
     19|8
    176
    ---
     19|5
    110
    ---
     12|9
   198
   ---
    2|10
   22
   --
   24
```

We stop at this point because 24 was a previous modified dividend, written under the form 240 above. Our two infinite numbers (which need not in practice be written down) are, with their difference, —

$$
\begin{array}{r}
\dot{1}0,958,90\dot{4},058 \\
\underline{\dot{1}0,958,90\dot{4},109.58904\dot{1}0958904\dot{}} \\
51.58904\dot{1}095890\dot{4}
\end{array}
$$

Hence the quotient sought is $5.\dot{1}5890410\dot{9}$.

Example 2. Find the reciprocal of 333667. The whole work is here given: —

```
  33366|7                        7
 233567                    1634969
                          2102103
                          226559|9
                         2102103
                         232866|2
                         467134
                         700000
```

Answer, $.\dot{0}0000299\dot{7}$.

Example 3. Find the reciprocal of 41.

```
Solution. —  41                     9
            37|9                   33|3
                                  111
                                  144
                                 148
                                 16|2
                                 74
                                 90
```

Answer, $.\dot{0}243\dot{9}$.

C. S. PEIRCE.

URNATELLA GRACILIS, A FRESH-WATER POLYZOAN.

A PAPER on this polyzoan, by Professor Joseph Leidy, has been recently published, with illustrations, in the *Journal of the Academy of natural sciences of Philadelphia*. Urnatella was originally discovered in 1851, and briefly noticed in the Proceedings of the academy the same year, and also subsequently in 1854, 1858, and 1870. It was found in the Schuylkill River at Philadelphia, but has not been seen elsewhere, except a dried but characteristic specimen on the shell of a Unio from Scioto River, Ohio.

Urnatella is an interesting and beautiful form, living in association with Plumatella and Paludicella, and having similar habits, but is very different from them or any other known fresh-water polyzoan, and is most nearly related with the marine genus Pedicellina. It is found attached to the under side of stones beneath which the water can flow. As commonly observed, it consists of a pair of stems divergent in straight lines, or rather gentle curves, from a common disk of attachment. The stems slightly taper, and are beaded in appearance, due to division into segments alternately expanded and contracted. The segments commonly range from two to a dozen, proportioned to the length of the stem, which, when longest, is about the eighth of an inch or a little more. The stems terminate in a bell-shaped polyp, with an expanded oval or nearly circular mouth slanting to one side, and furnished with about sixteen ciliated tentacles. The stems also usually give off a pair of lateral branches from the second segment succeeding the polyp, and frequently likewise from the first segment. The branches consist of a single segment or pedicle supporting a polyp, and usually also give off similar secondary branches. The first and second segments are cylindroid, highly flexible, and mostly striated and colorless, and appear mainly muscular in structure. The succeeding segments are urn-shaped; the body of the urn being commonly pale brown, ringed with lines, and marked with dots of darker brown. The neck and pedicle of the urns are black. The different colors give the stem a beaded and alternately brown and black appearance. Through the lighter colored body of the urns a central cord can be seen, extending through the length of the stem. The urn-shaped segments exhibit lateral pairs of cup-like processes, which correspond in position with the branches from the terminal pair of segments of the stem, and apparently indicate branches which have separated from the parent stem to establish themselves elsewhere as new polyp-stocks.

A series of specimens of Urnatella — from such as consist only of a simple cylindrical, flexible pedicle, supporting a polyp, to those with long stems, consisting of a dozen segments — indicates the urn-shaped segments to be formed successively through segmentation of the originally single simple pedicle. The segments, therefore, do not correspond with what were polyps; but the terminal polyp is permanent, and the segments originate by division from its neck, very much as the segments of the tape-worm arise from its head. After the destruction of the head, the segmented stem remains persistent; but what becomes of it ultimately has not been determined. Probably the segments may serve the purpose of the statoblasts of other fresh-water polyzoa, but the question has not

FIG. 1. — Urnatella gracilis. The one on the left with the polyps expanded; that on the right in the condition assumed when the animal is disturbed.

been ascertained. A common mode of propagation of Urnatella appears to be by budding, the formation of branches with their terminal polyps, and the detachment of these branches to establish stocks elsewhere. The different specimens apparently indicate this process, though it was not actually observed.

Though the stem of Urnatella is invested with a firm, chitinous integument, it still retains its flexibility; so that, when the polyp is disturbed, it not only closes its bell, and bends its head, but the entire stem bends, or even becomes revolute. Sometimes the polyps suddenly twist the stems from side to side, as if they had become wearied of remaining longer in the same position.

Fig. 2. — Urnatella gracilis, with the main stem of four segments, and a terminal expanded polyp. Branches are given off by the third segment, and a bud from the fourth.

The interior of the polyp is mainly occupied by the alimentary apparatus. From the mouth of the bell a funnel converges as the pharynx; and the tube of the former, as the oesophagus, occupies the shorter side of the bell. At the bottom of the latter the oesophagus opens into a capacious retort-like stomach, which occupies two-thirds of the capacity of the polyp. The stomach towards the mouth of the bell has an alembic-like pylorus, from which a short intestine turns ventrally to expand in an oval colon. From this a short rectum opens about the centre of the mouth of the bell. The pharynx, oesophagus, and stomach are lined with ciliated epithelium. The ventral side of the stomach has the epithelium colored brown, indicating, as in other polyzoa, an hepatic function. The polyp feeds on vegetable particles mainly, including diatoms, desmids, etc.; and the food may be observed in an incessant whorl in the axis of the stomach, induced by the action of the cilia lining the latter. The polyp is almost constantly infested with parasites, often in large numbers, which mingle with the food, and accompany this in its movement. The parasite is a ciliated infusorian, distinguished with the name of Anoplophrya socialis. From time to time, remains of the food are passed into the colon, and here accumulated into an oval pellet, which is then quickly discharged from the mouth of the bell.

Generative organs, or provision of any kind for the production of ova, were not detected, nor were eggs observed.

Urnatella differs from the marine genus Pedicellina mainly in not having an attached and creeping rootstalk, and in having free, pendent, and jointed stems, instead of simple pedicles.

THE PHYLOGENY OF THE HIGHER CRUSTACEA.

The class Crustacea is one of the dominant groups of the animal kingdom, and it includes a very considerable proportion of our living animals. Its representatives are extremely diversified in structure; and a single order, such as the Decapoda, includes a much greater variety and diversity of forms than the whole class of insects. It is very rich in primitive and transitional forms; and when we add to this, that there is no group in which our embryological knowledge is more rich and varied, or in which the embryological history of the individual throws so much light upon the evolution of the race, its importance as a means for tracing the actual history of the evolution of species is obvious. In fact, most of the problems in the logic of morphological reasoning, are, in great part at least, problems in the morphology of the Crustacea.

Since the awakening in natural science which followed the publication of the Origin of species, many naturalists have attempted to disentangle the story of the phylogeny of the Crustacea. Some of these attempts, such as Müller's 'Für Darwin' and Huxley's 'Crayfish,' are familiar to all; while others, such as Claus' 'Crustaceen system,' are known to none except specialists. The latest attempt in this field ("Studien über die verwandtschaftsbeziehungen der Malakostraken," by Dr. J. E. V. Boas, *Morph. jahrb.*, viii. 4, 1883) is, to say the least, a very valuable addition to crustacean morphology, as well as an interesting study in scientific logic. Its results seem to be a close approximation to the true natural classification of the higher Crustacea, and it should therefore receive the careful attention of all naturalists, and of all who wish to be informed regarding the methods of thought in morphology; but as it is from necessity filled with minute details, which would be formidable to all except specialists, the general reader must be contented with a summary of the results.

The proof that the crabs are descended from long-tailed decapods is familiar to all naturalists; and no one can doubt, that, among these, the swimming decapods, such as Penaeus, are the most primitive. So far, the phylogeny of the decapods may be regarded as definitely settled, and Boas proposes no modification of the accepted view; but his opinion regarding the origin of the swimming decapods from the lower Crustacea is novel, and the evidence which he furnishes seems to be conclusive. The Decapoda are generally regarded as the modified descendants of the schizopods; but Boas points out that the order Schizopoda is not a natural group, since the animals which have been included in it belong to two widely separated orders.

According to this author, the Euphausiacea and the Mysidacea are not at all intimately related. The latter are not in the line which leads to the Decapoda, and there is no natural group Schizopoda. He therefore divides the group into two orders, — the Euphausiacea and the Mysidacea: the former including the primitive unspecialized forms through which the Decapoda have been evolved from the lower Crustacea; and the latter containing highly specialized forms, which have been evolved from the Euphausiacea along an independent line, and which have no direct relationship to the Decapoda. He holds, that the Euphausiacea are a synthetic group of Crustacea which has given rise to several divergent groups of descendants. Of these, the decapod stem has undergone the least modification. A second stem, the Mysidacea, has diverged in an entirely different direction, has departed very widely from the primitive form, and has, in its turn, given rise to the Cumacea, and through these to the amphipods and isopods, the latter being the most highly modified of the Malacostraca. A third line of descent from the Euphausiacea has given rise to the Squillacea.

The recognition by Boas of the fact, that the group Schizopoda is not a natural one, and the discovery that the animals which have been thus associated may be divided into a very primitive group, the Euphausiacea, and a highly specialized group, the Mysidacea, seems to be a very great advance in crustacean morphology.

He gives the following definition of the Euphausiacea: —

Malacostraca, with the mid-body and abdomen compressed, with a well-marked bend in the abdomen; carapace well developed; the last segment of the mid-body a complete ring; eyes stalked; antenna with a large scale; mandible simple; first maxilla with broad, one-jointed palp, and with well-developed exopodite; second maxilla with a similar palp, and with exopodite, and a cleft lacinia interna. The appendages of the mid-body or cormopods all have a well-developed exopodite, and an epipodite which is subdivided in all except the first pair, where it is simple. The endopodite is thin and weak, and it does not end in a sharp point: it is more or less rudimentary on the last two pairs. The first cormopods are not specialized as maxillipeds, but are like the others. The abdominal feet are powerful swimming-organs, with an appendix interna. In the male the first or most anterior ones are specialized as copulatory organs. The tail-fins are well developed. The liver is composed of a great number of small lobes. The heart is short and wide. The halves of the reproductive organ are united by a transverse unpaired portion. Spermatophores are present, and the spermatozoa are simple round cells. There is an antennary gland. The young leaves the egg as a free-swimming nauplius, and the carapace of the older larva is a great phyllopod-like mantle.

It is easy to trace the relationship between this group and the decapods, on the one side, and, on the other side, through Nebalia, to the phyllopods and lower Crustacea.

The Decapoda natantia resemble the Euphausiacea in many conspicuous and highly important particulars. In these two groups alone, among the Malacostraca, we have a free-swimming nauplius; and in both the carapace of the larva is a great mantle. The abdomen is bent in both, and the integument is horny. The carapace, the abdominal appendages, the large tail-fin, and the pointed telson, are alike in both. The endopodite of the first pleopod is a copulatory organ in the decapods as well as in the Euphausiacea; and spermatophores are almost universal in these two groups, while they are found in no other Malacostraca.

The close relationship between these two groups can hardly be questioned; nor is it difficult to show that the Euphausiacea are the primitive, and the Decapoda the derived, form. In the presence of simple epipodites, and of a four-jointed palp on the first maxilla, the Penaeadae are nearer to the phyllopods than Euphausia; but in all other respects Euphausia is the most primitive, and it shows its close relationship to the lower Crustacea by many characteristics, among which are the following. The terminal joint of the cormopods is rounded and blunt, as it is in Nebalia, instead of being pointed, as it is in all the Malacostraca except Nebalia. There are no specialized maxillipeds; but the first cormopod is like all the others, as it is in Nebalia, and all the cormopods are furnished with exopodite and epipodite: while in all other Malacostraca there are true maxillipeds; and either the exopodites or the endopodites, or both, are absent on some or on all the cormopods. The antenna has a well-developed exopodite; and in the young this is flabellum-like, and very similar to that of the adult Limnadia or Estheria. This feature of resemblance to the lower Crustacea is shared by the young of the Decapoda natantia. The first maxilla has a large exopodite; while this is rudimentary in the Decapoda and Mysidacea, the only other Malacostraca where it occurs at all. The pleopods are much like those of Nebalia: they are efficient swimming-organs, and they are provided with an appendix interna. The spermatozoa, like those of the phyllopods, are simple round cells without tails; and this is true of no other Malacostraca except the squillas.

While the Euphausiacea are thus seen to be very much like the phyllopods in so many important features, they are true Malacostraca; and they have deviated greatly from their phyllopod ancestor, and have acquired a small carapace, differentiated cormopods with long slender endopodite, small exopodite divided into shaft and flabellum, and an epipodite which is purely respiratory. They also differ from Nebalia in the possession of that distinctively malacostracan organ, a tail-fin, made up of a telson and a pair of swimmerets.

The relationship of Nebalia to the Malacostraca on the one hand, and to the phyllopods on the other, has long been recognized, and Claus has even gone so far as to hold that this form is a true malacostracan; but Boas believes that it is neither a true malacostracan, nor the phyllopod from which the Malacostraca originated, but simply the nearest living ally of this ancestral form.

He believes that the presence of a great mantle-like carapace, of eight unspecialized, broad cormopods with leaf-like exopodites, of a furcated abdomen without tail-fins, and of eight abdominal somites, show that it is not a malacostracan, but a phyllopod. As many phyllopods, such as Limnetis and the Cladocera, have, like the Malacostraca, an exopodite on the second antenna, we must believe that the Malacostraca have inherited this feature from their phyllopod ancestor; and, as it is absent in Nebalia, this form cannot be the direct ancestor of the Malacostraca. So, too, the fifth and sixth pairs of abdominal feet are rudimentary in Nebalia, while they are well developed in nearly all Malacostraca. As most of the phyllopods, and some of the Malacostraca, leave the egg as a free-swimming nauplius, we must believe that this was true of the phyllopod ancestor of the Malacostraca; but as Nebalia does not pass through a free nauplius stage, but leaves the egg in a more advanced condition, it cannot be in the direct line of evolution. Boas therefore concludes that Nebalia is a true phyllopod, and that the Malacostraca have originated from a form somewhat different, although Nebalia is the closest living ally of this ancestral form.

Having thus traced the decapods back through the Euphausiacea to a phyllopod ancestor very similar to the recent Nebalia, we have now to trace the ancestry of the other Malacostraca. Boas holds that the squilloids are a branch from the Euphausiacea, and that the Mysidacea have been derived from the Euphausiacea along still another line of descent, and have, in their turn, given rise to all the remaining groups of Malacostraca.

The Mysidacea differ from the Euphausiacea and the decapods in many features which they show in common with the Cumacea and the amphipods and isopods; and it is not difficult to show, that, in these points of difference, the Euphausiacea are the primitive group, and the Mysidacea the modified group.

In Euphausia, as in the swimming decapods, the body and abdomen are compressed; while they are flattened and rounded in the Mysidacea, and the tip of the abdomen is directed backwards, lacking the peculiar bend of Euphausia and Penaeus.

The structure of the mandible is very instructive. In Mysis, as well as in the Cumacea and amphipods and isopods, the mandible is forked, the cutting part being widely separated from the crushing part; and between the two there is a row of setae, and a peculiar accessory appendix. In Euphausia and the decapods the appendix and row of setae are absent, and the chewing part is hardly separated from the crushing part. In Mysis, as in Cuma and the amphipods and isopods, the palp and exopodite of the first maxilla are absent, and the laciniae are turned forwards as well as inwards; and in all these forms the laciniae of the second maxilla are directed forwards. They overlap, and the lacinia interna is undivided. In Euphausia, the decapods, and squillas, there are no brood-pouches; but these structures are present in Mysis, as well as in the Edriophthalmata, and they are formed in essentially the same way in all, — by plates which are developed on the basal joints of certain of the cormopods. In all these forms the young pass through a long metamorphosis within these pouches. The liver is comparatively simple. There are no spermatophores, and the spermatozoa have tails. The Cumacea are regarded by Boas as a greatly modified offshoot from the Mysidacea; and the amphipods and isopods are derived from an ancestral form somewhat like, but more primitive than, the living Cumacea.

As regards the position of the amphipods and isopods, Boas's view is directly opposite to that which has been generally accepted; as he regards these as the most highly specialized and divergent of the Malacostraca, instead of low and primitive forms. The conspicuous segmentation of the nervous system, the absence of a carapace, the sessile position of the eyes, the great number of similar somites, the worm-like shape of the body, and the elongation of the heart, — all seem at first sight to show that these forms are ancient and low. Boas points out that the nervous system gives no proof of a primitive condition, as there are as many independent ganglia in Mysis as there are in the sessile-eyed Crustacea. It is true that the heart is longer than it is in Mysis; but there are only three pairs of ostia, and the length of the heart, as compared with that of the mid-body, is no greater than it is in Mysis. As the eyes are stalked in Nebalia, the nearest ally of the Malacostraca, all of the latter must have inherited stalked eyes from their phyllopod ancestors, and the sessile eyes of the Edriophthalmata must be due to secondary modification. So, too, regarding the absence of a carapace. As the Malacostraca inherit this structure from the phyllopods, those forms in which it is absent must have lost it by secondary modification. The same thing is true of the absence of a scale on the antenna. There is, therefore, no proof that these animals are primitive; and the many points of resemblance to the Mysidacea which we have just noticed show the close relationship between these groups. But as the Mysidacea, like Euphausia and the decapods, have stalked eyes, a carapace, and a fused mid-body, exopodites in first maxillae, exopodites and palpi in second maxillae and on cormopods, and as a seventh abdominal segment is present, we must believe that the Mysidacea are the more primitive group, and the Edriophthalmata their recently modified and highly specialized descendants.

Boas believes that most of these differences are due to the fact that the Edriophthalmata have become adapted for running instead of swimming; and he thus explains the loss of the exopodites of the cormopods, the strengthening of the endopodites, the shortening of the abdomen, the loss of power in the pleopods, the flatness of the body and abdomen, the thickening of the integument, and the loss of eye-stalks and of the antennary scale. The respiratory function of the pleopods he attributes to the loss of the carapace, and the thickening of the integument.

The general conclusions of this highly suggestive and interesting paper may be summarized as follows.

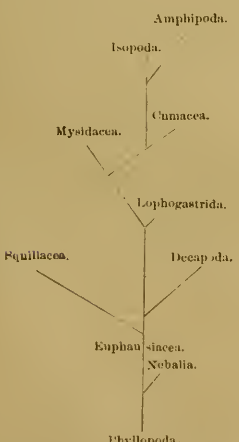
The Malacostraca are descended from the phyllopods, among which Nebalia is their nearest relative.

The Euphausiacea are the most primitive Malacostraca. The decapods originated from the Euphausiacea, although the most primitive decapods, the Natantia, are now widely separated from this ancestral form. The Squillacea stand by themselves, their nearest, although distant, allies being the Euphausiacea. They show in certain points a more primitive condition than any other Malacostraca; although, as a whole, they are highly modified.

The Mysidacea are also derived from the Euphausiacea; although they are so different from them that they must be placed in a distinct order, and the group Schizopoda must be abandoned. The Mysidacea have no close relationship to the decapods.

The Cumacea arise from the Mysidacea, and the amphipods and isopods from a form between the Mysidacea and the Cumacea. The amphipods and isopods are not a primitive group distantly related to the Podophthalmata, but they are the most highly specialized of the Malacostraca.

He gives the following as his phylogenetic classification of the Crustacea: —



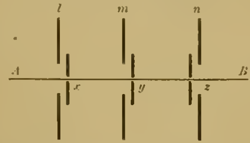
W. K. Brooks.

LETTERS TO THE EDITOR.

Radiant heat.

Mr. Fitzgerald has favored me with a paper [1] in which he takes exception to my views respecting radiant heat,[2] wherein he says, —

"Suppose that two regions, *A* and *B*, be separated by three parallel screens, *l*, *m*, and *n*, having apertures in them, *x*, *y*, *z*, capa-



ble of being opened and closed from the centre, so as to make everything perfectly symmetrical round the line *AB*, perpendicular to the screens. Now, if *x* be opened for a very short time, a certain quantity of radiant energy will escape out of *A* into the region between *l* and *m*; and if *y* be opened when this heat reaches *m*, it can certainly be let on into the region *mn*; and if *z* be similarly opened when it reaches it, this radiant heat will get into *B*. While *z* was open, however, some heat left *B*; but, as Dr. Eddy observes, *y* may be closed so as not to let this even get through the screen *m*, and it can be all returned into *B* by reflection through *z* or some other aperture. So far I entirely agree with Dr. Eddy, and so far it seems as if the result had been to transfer heat from *A* to *B* without *B*'s losing any heat by having it transferred to *A*. As I warned Dr. Eddy when I heard his paper, there are, however, other bodies and regions to be considered besides *A* and *B*. There are more than two bodies considered: there is the region of the screens. Consider what happens when the heat that escaped out of *B* into the *mn* region tries to get back into *B*. Some door must be opened to let it pass; and, while it is passing in, an at least equal amount of heat will be passing out of *B* into the *mn* region, so that you can never really get the heat that has once left *B* back into *B* again. This is true, whether you adopt doors over fixed apertures, such as I have supposed, or moving apertures, such as Dr. Eddy proposed. What really takes place is this: a certain quantity of heat escapes out of *A* and reaches *B*; and a not less quantity of heat leaves *B*, and is kept entangled in the region of the screens, and it is only possible to let the heat pass from *A* to *B* by means of this third region. Hence this only really comes to the same thing as letting *A* radiate some of its heat into the screen region, while *B* is kept closely shut up. Now, be it observed that Dr. Eddy practically postulates that this screen region is at least colder than *A* — in fact, he assumes it to be perfectly cold, i.e. to contain no radiant heat except what is admitted from *A* and *B*, so that it is by no means contrary to the theory of exchanges that *A* might cool by radiating into this region."

Now, Mr. Fitzgerald has stated only two of the three things which occur while the door *z* is open. He omits to state, that in my process a certain amount of heat which has come from *A* also passes through the door *z* every time it is opened, into the region *B*; and this is all which is proposed to be accomplished by the process which is at all unusual or peculiar. Thus the fact remains, that although a definite amount of heat from *B* remains entangled in the region *mn*, which is not increased with the lapse of time, there is a continued passage of heat through this region into *B*, that being the very object sought to be accomplished by my process. It is not easily seen how the arrangement of screens and apertures proposed by Mr. Fitzgerald could be so manipulated as to bring the heat coming from *A* into a position such

[1] On Dr. Eddy's hypothesis that radiant heat is an exception to the second law of thermodynamics. By George F. Fitzgerald, M.A., F.T.C.D., *Sc. proc. roy. Dubl. soc.*, iv. pt. 1.
[2] *Sc. proc. Ohio mech. inst.*, July, 1882.

that it would be in readiness to pass into B at the same time as the heat which originally came from B is returned to B, though my arrangement of moving screens readily accomplished this, as was admitted by Prof. J. Willard Gibbs in his criticism of my paper.[1]

H. T. Eddy, Ph.D.

Area of a plane triangle.

In the *Mathematical magazine* (Erie, Penn.) for April, Mr. James Main publishes, as a matter of curiosity, a collection of ninety-four expressions for the area of a plane triangle. In *Mathesis* (Gand, Belgium) for June this list is republished; and in the August number of the same journal the subject is taken up again by M. Ed. Lucas, who extends the collection, and classifies into five groups. In the first group are eleven '*unique*' expressions for the area, i.e., expressions that do not admit of other similar expressions by permuting the letters; in the second group are nine expressions, each admitting of two other similar expressions by permuting the letters; in the third group are eleven expressions, each admitting of three other similar expressions; in the fourth group are seven expressions, each admitting of five similar expressions; and, last, the fifth group consists of a single formula, admitting of eleven similar expressions. Thus we have a hundred and thirty-six expressions for the area of a plane triangle in terms of the sides, angles, perpendiculars, semiperimeter, and radii of the circumscribed, inscribed, and escribed circles. M. Neuberg adds also three other unclassified formulae, with the statement that many other such may be found. The total number of expressions for the area of a plane triangle, in this collection, is therefore a hundred and thirty-nine, making it, perchance, the most complete collection that has been published. M. B.

The Dora coal-field, Virginia.

In the November number of *The Virginias* is contained a review of the report on the mineral resources of the United States, recently published by the U.S. geological survey, which contains the following: — "In Mr. Charles A. Ashburner's report on anthracite coal, p. 32, is this statement concerning the Dora coal-field: 'Of one of the reported anthracite localities in Virginia, that in Augusta county, recent tests with the diamond-drill would seem to prove the presence of anthracite,'" etc. In explanation of the above, I would like to state, that, by referring to the report reviewed, on p. 24 will be found a footnote as follows: "Mr. Ashburner's contribution and statistics end here." I only stand responsible for a *portion* of the statistics relating to the anthracite region in Pennsylvania (pp. 7 to 24 inclusive). I desire to make this explanation public from the fact that I do not wish to be held accountable for *questionable data* relating to a coal-field of a very uncertain character, and which I have never examined.

Charles A. Ashburner,
Geologist in charge Penn. anthracite survey.

Philadelphia, Penn.

Synchronism of geological formations.

In Science of Dec. 7 your correspondent, Mr. Nugent, takes issue with me as to my conclusions bearing upon the relative ages of geological formations, and contends that the geological and paleontological researches of the last twenty-one years (i.e., during the period that has elapsed since the publication of Professor Huxley's address referred to in my communication before the Philadelphia academy of natural sciences) have only tended 'to maintain the logical basis' on which the distinguished English naturalist rested. As the subject is a very important one, and one that has not, it appears to me, received its full measure of attention or discussion, I trust that you will permit me a little space for fuller explanation, even at the risk of repeating what has already been said in your valuable columns.

Professor Huxley, in his anniversary address delivered before the London geological society in 1862 (*Quart. journ.*, xviii. p. xlvi), maintains substantially, —

I. That formations exhibiting the same faunal facies may belong to two or more very distinct periods of the geological scale as now recognized; and, conversely, formations whose faunal elements are quite distinct may be absolutely contemporaneous: e.g., "For any thing that geology or paleontology is able to show to the contrary, a Devonian fauna and flora in the British Islands may have been contemporaneous with Silurian life in North America, and with a carboniferous fauna and flora in Africa" (*loc. cit.*).

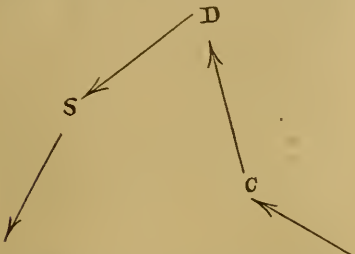
II. That, granting this disparity of age between closely related faunas, all evidence as to the uniformity of physical conditions over the surface of the earth during the same geological period (i.e., the periods of the geological scale), as would appear to be indicated by the similarity of the fossil remains belonging to that period, falls to the ground. "Geographical provinces and zones may have been as distinctly marked in the paleozoic epoch as at present; and those seemingly sudden appearances of new genera and species which we ascribe to new creations may be simple results of migration."

Now, without wishing to enter into the minutiae of the question, I believe a little reflection will clearly show, that if, as it is contended, several distinct faunas (i.e., faunas characteristic of distinct geological epochs, and separated in age from each other by possibly millions of years) may have existed contemporaneously, "evidences of inversion," to quote my own words, "in the order of deposit, ought to be common; or, at any rate, they ought to be indicated somewhere, since it can scarcely be conceived that animals everywhere would have observed the same order of direction in their migrations." Given the possible equivalency in age, as hypothetically claimed, of the Silurian fauna of North America with the Devonian of the British Isles and the carboniferous of Africa, or any similar arrangement, why has it never happened, it may be asked, that when migration, necessitated by alterations in the physical conditions of the environs, commenced, a fauna with an earlier life-facies has been imposed upon a later one, as the Devonian of Great Britain upon the carboniferous of Africa, or the American Silurian upon the Devonian of Britain? Or, for that matter, the American Silurian may have just as well been made to succeed the African carboniferous. Reference to the annexed diagram, where D represents a Devonian area, say, in Europe, S a Silurian one in America, and C a carboniferous one in Africa, — all contemporaneous, — will render this point more intelligible.

Now, on the proposition here stated, reasoning from our present knowledge of the antiquity of faunas, and accepting the doctrine of migration, as maintained by Professor Huxley and others, to account for the possible contemporaneity of distinct faunas, it may be assumed that S (or America) will receive its Devonian fauna from D; D (Europe), its carboniferous from C; and C (Africa), a later fauna from some locality not here indicated. In other words, a migra-

[1] Science, i. 160.

tion, as indicated by the arrows, would set in from D to S, one from C to D, one from S to some possibly South American Cambrian locality, and one, bringing a Permian or some later-day fauna, from an unknown locality towards C. Were this order of migration to continue here, or at other portions of the earth's surface, in this or in a similarly consecutive manner, the results obtained would be in perfect consonance with the facts presented by geology. But is there any reason whatever for the continuance of this order of migration? Surely no facts that have as yet been brought to light argue in favor of a continued migration in one direction. Why, then, it might justly be asked, could not just as well a migration take place from S to D, and impose with it a Silurian fauna upon a Devonian? What would there be to hinder



a migration from S to C, placing the American Silurian fauna upon the carboniferous of Africa? Why, as I have asked, has it just so happened that a fauna characteristic of a given period has *invariably* succeeded one which, when the two are in superposition all over the world (as far as we are aware), indicates precedence in creation or origination, and *never* one that can be shown to be of a later birth? Surely these peculiar circumstances cannot be accounted for on the doctrine of a fortuitous migration. And it certainly cannot be claimed that through a process of transmutation or development, depending upon the evolutionary forces, a fauna with a Silurian facies will, in the course of a possible migration toward a carboniferous locality, have assumed a carboniferous or Permian character.

The facts of geology and paleontology are, it appears to me, decidedly antagonistic to any such broad contemporaneity or non-contemporaneity as has been assumed by Professor Huxley; and their careful consideration will probably cause geologists to demur to the statement that "all competent authorities will probably assent to the proposition that physical geology does not enable us in any way to reply to this question: Were the British cretaceous rocks deposited at the same time as those of India, or are they a million of years younger or a million of years older?"

Angelo Heilprin.

Academy of natural sciences,
Philadelphia, Dec. 8.

THOMSON AND TAIT'S NATURAL PHILOSOPHY.[1] — II.

Before proceeding to an account of the rest of the work, we shall add a few more words of explanation upon the harmonic solutions of the differential equation (6), expressed in polar co-ordinates. On attempting to integrate this equation, it is found that there is an infinite number of particular solutions, as was before stated must necessarily be the fact; and each of these solutions is the product of three factors. One factor is an arbitrary constant; another factor is the radius vector raised to any integral power, positive or negative; and the remaining factor is a function of the angular co-ordinates, dependent for its form upon the exponent of that power of the radius vector by which it is multiplied. It is this last factor, or coefficient, which gives the name of 'spherical harmonics' to the solution: indeed, these functions of the angular co-ordinates are themselves surface-harmonics.

If we restrict ourselves, as is usually done, to real integral powers of the radius vector r, positive and negative, then, from the well-known principle that a general solution is obtained by taking the sum of particular solutions, we should have the most general possible solution by taking the sum of a series of particular solutions, such as have just been described, in which the powers of r have all integral values between $+\infty$ and $-\infty$. But since it is found, upon computing the functions of the angular co-ordinates which constitute their coefficients, that the coefficients of r^i and $r^{-(i+1)}$ are identical, it will be more convenient to write the general solution in the form —

$$V = a_0 f_0(\theta,\phi) + (a_1 r + b_1 r^{-2}) f_1(\theta,\phi) + (a_2 r^2 + b_2 r^{-3}) f_2(\theta,\phi) + \dots + (a_i r^i + b_i r^{-(i+1)}) f_i(\theta,\phi) + \dots \quad (8)$$

In applying this to any given case, either all the arbitrary constants a vanish, or all the constants b; thus giving rise to the two general forms of solution before mentioned, in which there is a series of terms, either in ascending integral powers of r, or of descending integral powers of r.

A value of V consisting of several terms is a compound spherical harmonic of the degree (positive or negative) of its numerically highest power of r. A value of V consisting of a single term is a simple harmonic.

Returning, now, to the consideration of chapter vii. p. 98, entitled 'Statics of solids and fluids,' the subject of rigid solids is disposed of in the course of thirty pages, nearly half of which is occupied with inextensible strings in the form of catenaries of various kinds.

The authors hasten on to the more intricate matter of elastic solids. As is well known to students of this subject, the general problem

[1] Concluded from No. 36.

of finding the displacements in all parts of an elastic solid of any figure subjected to the action of known forces applied to its exterior surfaces, even when the solid is uniform in texture in all directions (i.e., isotropic), transcends at present the powers of analysis, though considerable progress has been made toward a complete theory. An important contribution to this theory by Sir William Thomson is found on pp. 461 to 468 in Appendix C, entitled 'Equations of equilibrium of an elastic solid deduced from the principle, energy.'

By reason of the incompleteness of the general theory, those simple cases are first treated which are most completely amenable to analysis. The forty pages succeeding p. 130 treat the special case of the elastic wire, whose fundamental equations were first thoroughly investigated by Kirchhoff in 1859. This treatment, which is of interest both to the mathematician and engineer, investigates not only the spirals which elastic wires of circular and of rectangular cross-section assume under the action of direct forces, and of couples producing bending and twisting, but also goes into several important side-issues, one of which is the so-called kinetic analogy. A simple case of this, which is discussed at length, exists between the plane curves assumed by a thin flat spring, and the vibrations of a simple pendulum which it graphically represents. Another important side-issue is found in the discussion of the common spiral spring, in which the force resisting elongation is mostly due to torsion of the wire. Very curiously, the theorem of three moments of a straight beam is omitted, although the principles to be employed in establishing it are fully given.

Another important elastic solid which is fully amenable to analysis is the thin elastic plate. The treatment of the thin plate, which occupies thirty pages, discusses the flexure of a plane plate under all combinations of forces tending to produce either a state of synclastic stress (i.e., a state in which the curvature at every point is convex) or a state of anti-clastic stress (i.e., one which tends to cause the surface to become saddle-shaped). Kirchhoff's boundary conditions for a plate are also demonstrated at length. These are of importance in most practical cases, — as, for example, that of the flat steam-boiler head; for evidently any plate must have some kind of support or fastening at its boundary.

The general subject of elastic solids is reached at p. 204, and occupies a hundred pages, in which, after the general equations of equilibrium between the applied stresses and the resulting strains are established, several special cases are treated at length. The first of these is the celebrated torsion problem published by St. Venant in 1855; in which the distribution of the stresses and strains throughout a right prism of any cross-section whatever, under the action of forces applied to its ends, is completely determined. This is perhaps the most complicated problem which has been entirely worked out in the subject of elastic solids, and twenty-four pages are devoted to it. The flexure of beams having rectangular cross-sections is discussed, especially with reference to the distortions which are suffered by these cross-sections. The distortions can be easily exhibited by bending a thick rectangular piece of rubber, when the upper and lower surfaces will become saddle-shaped.

The general problem is then further treated by investigating the case of an infinite elastic solid under various suppositions as to the force applied through limited and through unlimited portions of it. The spherical and cylindrical shells are then treated by the help of harmonic analysis.

The concluding hundred and sixty pages of the work, beginning at p. 300, are devoted ostensibly to hydrostatics; but the first twenty-five pages finish those parts of the subject included under that title in ordinary treatises, and the remainder relates to the physics of the earth as dependent upon its fluid condition, past or present. The first great problem in this department of inquiry is to determine what figure will be assumed by a rotating liquid mass under the influence of centrifugal force and of the mutual gravitation of its parts. That an oblate spheroid is a figure of equilibrium for such a mass is commonly known, having been shown to be such by Newton; but that an ellipsoid with three unequal axes is also such a figure is not so commonly known, though this was discovered to be the fact by Jacobi in 1834. There are other possible figures, stable and unstable; but which of all these is the one which will actually be assumed in any given case? In reply to this question, the authors state, that "during the fifteen years which have passed since the publication of the first edition we have never abandoned the problem of the equilibrium of a finite mass of rotating incompressible fluid. Year after year, questions of the multiplicity of possible figures of equilibrium have been almost incessantly before us; and yet it is only now, under the compulsion of finishing this second edition of the second part of our first volume, with the hope for a second volume abandoned, that we have succeeded in finding any thing approaching full light on the subject" (p. 332). Then follows an enumeration of the possible forms of equilibrium, including the single and multiple rings into which an ellipsoid would be changed when rapidly rotated, and the detached portions, nearly spherical, into which an elongated ellipsoid must separate when rapidly rotated about its shorter diameter.

Now, on the supposition that the figure of the earth is approximately an oblate spheroid, the next matter of importance is to show how to compute the alterations in figure due to local inequalities in its density, and irregularities in the distribution of the material composing it. This at once raises the question as to what we are to consider as the surface of the earth at any point which forms part of its figure. The true figure of the earth may be taken to be the water-surface when undisturbed by tides. Whenever it is desired to find such surface on land, a canal could be supposed to be cut from the ocean to the place under consideration. Of course, a plumb-line is everywhere perpendicular to such a surface, whose outline is evidently affected by all existing inequalities of density and distribution of the substance of the earth. For example: it is computed that a set of several broad parallel mountain chains and valleys, which are twenty miles from crest to crest, and seventy-two hundred feet above the bottom of the valleys, would cause a corresponding undulation of the water-surface whose crests would be five feet above the bottoms of the hollows. This statement is equivalent to saying, that the plumb-line is deviated from its mean direction by the attraction of the mountain chains. Deviations of nearly 30″ have been actually observed near the Alps and near the Caucasus Mountains. The comparatively small deflections observed near the vast mass of the Himalayas in India — which, according to Pratt's calculations in his treatise on attractions, etc., should be vastly greater than any thing actually observed — indicate that extensive portions of the globe under those mountains are less than the average density. Localities have been found in flat countries also, notably in England and Russia, where the deflection of the plumb-line exceeds 15″, which is, of course, due to underlying material of great density. From this it appears, that the true figure of the earth is nearly as diversified as the contours of its hills and valleys, and does not correspond to any known geometrical figure; although, to be sure, these undulations are of small amount. Now, as a first rude approximation, the figure of the earth can be taken as a sphere, having the same volume as the actual earth. The earth at the equatorial regions will then project beyond the figure, and at the poles lie within it.

A second and better approximation can be made by taking the figure to be that of an oblate spheroid; and this is the basis upon which our present geodetic and astronomical measurements are based. Of course, it is possible to find an ellipsoid having three unequal axes which will coincide still more nearly with the results of observations upon the true figure of the earth; and this will furnish a third still closer approximation. This is what has been done by Capt. Clarke in his various publications. A summary of his results is given upon pp. 367 and 368.

It is evident, when the astronomical latitude is determined at any point of the earth's surface by measuring the elevation of the north pole above the horizon, as given by the spirit-level, that that determination will be in error by the entire amount of the local deviation of the plumb-line, which error may be as much as 30″, or more than half a mile, although the observations are made with all possible precision; and the outcome of geodetic triangulation may show that any such station whose position was supposed to have been determined astronomically to single feet really occupies a position, when referred to the spheroid, which at present furnishes the basis of all our astronomical and geodetic work, which is a considerable fraction of a mile from its position as so determined.

The last grand subject treated in the work is that of the tides on the corrected equilibrium theory, and matters closely connected with it. To explain what is meant by this, we shall briefly sketch the rise and progress of the theory of the tides.

Sir Isaac Newton, whose Principia appeared in 1687, showed that universal gravitation would not only account for the motions of the heavenly bodies in their orbits, but would also account for the tides, — phenomena whose cause had not, before his day, been traced to any simple law of nature. He showed that there would be a tide due to the attraction of the sun, and another to that of the moon, the latter being in general the larger; and that the actual tide would depend upon the relative position of those bodies, so that the highest or spring tides would be due to their combined effect, and the lowest or neap tides would occur when the tide due to the sun partially neutralized that of the moon. He showed how other known variations in the tide could be accounted for by the declinations of the sun and moon, and their greater or less distance from the earth.

. The cause of the tide may be roughly stated, according to the equilibrium theory, thus: the sun or the moon attracts the water on the side of the earth nearer to it more than it does the earth itself, and attracts the earth itself more than the water on the farther side; the consequence being that water is heaped up on the sides of earth away from and toward the attracting body. Or, more exactly, we may imagine

" The rise and fall of the water at any point of the earth's surface to be produced by making two disturbing bodies (moon and anti-moon, as we may call them for brevity) revolve around the earth's axis once in the lunar twenty-four hours, with the line joining them always inclined to the earth's equator at an angle equal to the moon's declination. If we assume that at each moment the condition of hydrostatic equilibrium is fulfilled, — that is, that the free liquid surface is perpendicular to the resultant force, — we have what is called 'the equilibrium theory of the tides'" (art. 805).

Newton made a modification of this theory, which was intended to take into account the rotation of the earth, by supposing that the full effect of the attraction was not exerted immediately under the attracting body, but that the tide was of the nature of a wave, and by its inertia lagged behind the place where it should have been found in case the earth was not rotating. This retardation he thought might be more than a whole day in some cases. He was not able to submit the whole theory to rigorous computation for lack of sufficient data as to the mass of the moon and the height of the tides; but, from the tidal observations then available, he computed the mass of the moon necessary to produce them according to his theory, and obtained a result which we know to-day to be about twice too large.

In 1738 the French academy proposed the problem of the tides as the subject of a prize-essay, and elicited important essays on the subject from Bernouilli, Maclaurin, and Euler, to each of which was awarded a prize, and in each something of importance was added to Newton's theory; but the foundations of an exact and complete theory were first made in the 'Mécanique céleste' by Laplace, in five volumes, 1799–1825.

The science of mathematical analysis had not been greatly developed at the time Newton wrought upon this subject. His work is expressed in geometrical forms in which his genius is unapproachable. But the new methods of analysis founded upon the calculus, the principles of which were discovered equally by Newton and by Leibnitz, received a rapid and wonderful development during the seventeenth century at the hands of Lagrange and the continental mathematicians. It was to the then existing state of advancement in this particular that the great success of Laplace was due, which enabled him to unravel to so remarkable a degree the intricate interactions of the bodies of the solar system, and give for the first time the fundamental equations of the tides on correct principles. But it must be admitted that Laplace, in integrating his differential equations, seems to have become involved in intricate formulae whose full significance he has not correctly interpreted.

At about the same time, Dr. Thomas Young made an important investigation of the action of the tides, which was published in the Encyclopaedia Britannica, where it has been republished in succeeding editions to the present day. The special point of importance in his investigation was the discussion of the effect of friction upon the tides, which he showed to be such as to explain many difficulties, and that its magnitude might be such as to completely change the character of the tide at certain places so as to make low water take the place of high water, and *vice versa*, — a result hitherto unsuspected, and of prime importance.

The next great step in the theory of the tides was due to Airy, in his article on 'Tides and waves' in the Encyclopaedia metropolitana. He gave in new and concise form a most useful *résumé* of Laplace's theory, and made an original investigation of the effects of friction. He also made valuable additions to the theory as applied to shallow seas and rivers, a subject hitherto untouched.

The labors of Lubbock and of Dr. Whewell have added much to our knowledge of the relations of the theory to the observed tides; but the two foremost cultivators of this branch of science now living are Thomson and Ferrel. The former, who is chairman of the committee appointed by the British association for the advancement of science, for the purpose of the extension, improvement, and harmonic analysis of tidal observations, has done much, by his improved methods of observing tides and discussing them, to separate their components from each other, and render the exact comparison of theory and observed facts possible. Laplace assumed that the fortnightly and semi-annual tides due to the movement of the moon and sun in declination move so slowly that the equilibrium theory applies to them with exactness. But even if that be admitted, it can be shown that the theory needs correction to take account of the relative amount of land and water, as well as the contour of the continents. These have a controlling influence upon the tides, and this discovery is Thomson's great improvement and correction of the equilibrium theory.

The diurnal tide has been usually explained, in accordance with the equilibrium theory, as a wave existing under nearly static conditions, and following the moon and sun around the earth, but interfered with by friction, and changed in direction by the contour of the land. Though this was the view of Newton, Young, and others, and is incorporated in our ordinary text-books, it is quite inadequate; and the kinetic theory of Laplace must be put in its place, which treats the water as a moving fluid body, subject to the disturbing influence not only of the sun and moon, but of itself also.

The kinetic theory of the tides was to have been developed at length in vol. ii.; and that intended development is more than once referred to by the authors, — as, for instance, on p. 382, where an incidental comparison is made of the results of the two theories.

This part of the theory has been treated by Ferrel in his 'Tidal researches,' published as one of the appendices to the U. S. coast-survey report for 1874, in which work he has put in practical shape all the theoretical work heretofore accomplished, and also deduced therefrom important consequences. Until the publication of this work, it was not possible to apply the correct theory to the discussion and prediction of tides by reason of the unmanageable formulae employed by Laplace; and the discussions were, perforce, made by some modification of the equilibrium theory. Indeed, Laplace himself resorted to that method in his famous discussion of the tidal observations in the harbor of Brest. But, thanks to Ferrel's labors, this most intricate branch of computation has been systematized, and applied to an extensive series of tidal observations in Boston harbor.

The concluding pages, from 422 to 460, treat the question of the rigidity and solidity of the earth as a whole, especially as related to the tides. The final sentence (p. 460) is, "On the whole, we may fairly conclude, that, whilst there is some evidence of a tidal yielding of the earth's mass, that yielding is certainly small, and that the effective rigidity is at least as great as that of steel."

Four important papers on subjects related to those just mentioned are added to the work as appendices. The titles of these papers are, 'Cooling of the earth,' 'Age of the sun's heat,' 'Size of atoms,' 'Tidal friction.' The last three of these were not in the first edition.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Fuchsian functions. — A previous paper by M. Poincaré on this subject has already been noticed in these pages (i. 535). In the present most important memoir, M. Poincaré assumes the results arrived at in the former memoir, and proceeds to more fully develop them and the consequences flowing from them. In the previous paper the author showed that it was possible to form discontinuous groups by substitutions of the form

$$\left(z, \frac{a_i z + \beta_i}{\gamma_i z + \delta_i}\right)$$

by choosing the coefficients $a_i, \beta_i, \gamma_i, \delta_i$, in such a way that the different substitutions of the group should not alter throughout the interior of a certain circle called the fundamental circle. In the present paper the author assumes that the fundamental circle has its centre at the origin, and its radius unity; so that its equation can be written as mod. $z = 1$.

He then considers one of these discontinuous groups, which he calls Fuchsian groups, and which he denotes by G. To this group corresponds a decomposition of the fundamental circle into an infinite number of normal polygons, R, all congruent among themselves. The author then demonstrates that there always exists a system of uniform functions of z, which remain unaltered by the different substitutions of the group G, and which he calls Fuchsian functions. M. Poincaré's memoir is too long to be reviewed here as it deserves. It is certainly a most important addition to the modern theory of functions, and is rendered particularly valuable by the historical note at the end, in which the author gives a brief account of the labors of Hermite, Fuchs, Klein, Schwarz, and others in this field. The two memoirs, with very little amplification, would constitute a really valuable treatise on this subject, — a subject of great importance, and on which there exists absolutely no text-book or treatise of any kind. — (*Acta math.*, i.) T. C. [506

ENGINEERING.

Steam-whistles. — Lloyd and Symes give a statement of experiments with a locomotive whistle having a bell $4\frac{1}{16}$ inches diameter, $3\frac{3}{4}$ inches long inside, and over an annular steam opening $\frac{1}{16}$ of an inch wide. The bell was of cast brass of medium character; and the lip was chamfered to a thin edge, and set exactly over the steam-opening. Sixty pounds pressure of steam gave E natural; 80 pounds, F sharp; 90 pounds, G; 110 pounds, A; and 125 to 130 pounds gave C sharp in alt. The distance from steam-opening to edge of whistle was 1½ inches. When it was increased to 2 inches, the power of the sound was sensibly lessened, but the pitch was altered relatively but half a tone. If the distance were decreased to 1 inch, or to ⅞ of an inch, the whistle would sound only supertones. The notes above were clear, even 'reedy,' and could be heard six miles. A bell of brass tubing, annealed, hammered, and then heated again, gave sounds of somewhat greater intensity and pitch. An iron bell was unsatisfactory. — (*Railr. gaz.*, Aug. 31.) C. E. G. [507

Economy of pumping-engines. — Mr. P. A. Korevaer compares the economy of the scoop-wheel, the Archimedean screw, the pump-wheel, the suction or bucket pump, the double-action pump, and the centrifugal pump, and reports the results to the Dutch institute of engineers. In the Netherlands the pump-wheel is used for lifts less than 2.5 metres (8.3 feet), and the screw for about 4.25 metres (12.5 feet); while the lift and volume delivered by the ordinary forms of pump are unlimited. The economical lift for a centrifugal pump is taken to be as a maximum at about 30 or 40 feet. Its cost in Holland is rather greater than that of a scoop-wheel. The latter gives an efficiency of 64 to 69.5 % on lifts varying from 4 to 6 feet (1.2 to 1.8 metres). The double-acting pump gives an efficiency of 67 to 73 % on lifts between 6.66 and 10 feet (2 to 3 metres). The centrifugal pumps tested gave from 17 to 70 % (averaging 45) in one place, and 40 to 49.3 (averaging 44) in another case. The coal used amounted to from 0.9 to 1.2 kilogr. with scoop-wheels for the drainage of one hectare and a lift of one metre, 1 to 1.17 with double-acting pumps, and 1.56 to 2.19 with centrifugal pumps. The author concludes that a decided gain is obtained by the use of other methods of pumping rather than by the use of the centrifugal pumps,— a conclusion which we may be allowed to agree in, with the qualification that the results would bear a somewhat different complexion if the comparison were with efficient centrifugal pumps, which should be capable of giving an efficiency of at least 66 %. — (*Abs. papers inst. civ. eng.*, 1882–83, iii.) R. H. T. [508

Electric head-light for locomotives. — The Sedlaczek head-light was exhibited at Munich at the late exhibition. It was made by Messrs. Sedlaczek & Wilkulill, as a modification of the lamp of Lacassagne & Thiers, of 1856. The current is supplied by a dynamo placed on the top of the boiler behind the smoke-stack, and driven by an independent engine. The lamp is arranged to turn automatically on curves so as to light the track at all times. The light was visible at a distance of 2½ miles (4 kilometres). The report of the committee intrusted with the observation of the action of the lamp states that the intensity (4,000-candle power) was so great that the guards reported that it dazzled their eyes to such an extent that they were unable to make the observations prescribed by the regulations. The committee express a fear that it may frighten horses. Their apprehensions remind us of the same difficulties as they presented themselves to the opponents of the railway itself. A report made on this lamp in 1881, when used on the Northern railway of France, stated that the experiment proved that the lamp was not extinguished by the jar of the train, and that it did not in any way affect the visibility or the appearance of colors in signals. Engineers of trains were not dazzled by it unless by looking at it persistently, and were not prevented, even then, from seeing the signals. It is proposed to apply the same system of lighting to the cars. — (*Railway rev.*, Oct. 6.) R. H. T. [509

CHEMISTRY.

(Organic.)

Constituents of petroleum from Galicia. — In the oil from this locality Br. Lachowicz has found a normal, and an iso-pentan, two hexans, one heptan, one nonan, and two decans. Other hydrocarbons of this series were present in smaller quantity. No members of the ethylen series were detected. Of the aromatic hydrocarbons, benzol, toluol, isoxylol, and mesitylen were identified. The quantity of 'Wreden's hydrocarbons' — hexahydrobenzol (C_6H_{12}), hexahydrotoluol (C_7H_{14}), and hexahydro-isoxylol — in the Galicia petroleum lies between that of the Caucasus and the American oils. — (*Ann. chem.*, 220, 168.) C. F. M. [510

Compounds of the indigo group. — In the course of his investigations upon the constitution of indigo, A. Baeyer has tried several reactions to determine the position of the hydrogen atom which is not in the benzol ring. If the formula

$$\begin{array}{l} C_6H_4 - CO \\ \;\;| \qquad\;\; | \\ \;N \;=\; COH \end{array}$$

is assigned to isatin, the isomeric form called by Baeyer pseudo-isatin would have the form

$$\begin{array}{l} C_6H_4 - CO \\ \;\;| \qquad\;\; | \\ HN - CO \end{array};$$

and the form of pseudo-indoxyl isomeric with indoxyl,

$$\begin{array}{l} C_6H_4 - COH \\ \;\;| \qquad\;\; \| \\ HN - CH \end{array},$$

would be

$$\begin{array}{l} C_6H_4 - CO \\ \;\;| \qquad\;\; | \\ HN - CH_2 \end{array}.$$

Baeyer draws the following conclusions from his results concerning the structure of indigo: —

1. It contains an imido group.
2. The carbon atoms have the arrangement

$$C_6H_5 - C - C - C - C - C_6H_5.$$

3. It is formed only from compounds in which the carbon atom next to the benzol ring has attached to it an oxygen atom.

4. In its formation and properties it is closely related to indirubin and the 'indogenides' of ethyl-pseudo-isatin.

5. The latter results from a union of the α-carbon atom of pseudo-indoxyl with the β-carbon atom of pseudo-isatin.

The formation of indigo may therefore be shown by the equation —

$$\begin{array}{ccccccccccc} C_6H_4 - CO & & CO - C_6H_4 & & C_6H_4 - CO & & CO - C_6H_4 & & \\ | \quad\quad | & + & | \quad\quad | & = & | \quad\quad | & & | \quad\quad | & + & H_2O. \\ HN - CH_2 & & CO - NH & & HN \quad C & = & C - NH & & \\ \text{Pseudo-indoxyl.} & & \text{Pseudo-isatin.} & & & \text{Indigo.} & & & \end{array}$$

— (*Berichte deutsch. chem. gesellsch.*, xvi. 2188.) C. F. M. [511

AGRICULTURE.

Maintenance of fattened animals. — Kellner having observed that simple maintenance-fodder was sufficient to prevent fatted sheep from losing weight, Vossler has tried the same proceeding with sheep and oxen, and confirmed Kellner's observation. — (*Biedermann's centr.-blatt.*, xii. 612.) H. P. A. [512

Relation of manure to quantity of seed. — In experiments on the drill-culture of barley, Märcker finds, that, as the distance between the drills is increased, the yield decreases, unless more nitrogenous fertilizer is applied. — (*Ibid.*, xii. 620.) H. P. A. [513

Seed-potatoes. — In an experiment with potatoes at the New-York agricultural experiment-station, single eyes gave better yields in proportion as they were located near the terminal portion (seed-end) of the tuber. — (*N. Y. agric. exp. stat., bull.* lxiv.) H. P. A. [514

Potato-culture. — Previous experiments having led to the hypothesis that the most favorable conditions for the growth of potatoes are coolness and moisture for the roots, and warmth and dryness for the tubers, an attempt was made to test the hypothesis by planting potatoes on ridges, and mulching the intervals. The season, however, was very wet, so that the desired conditions for the tubers were not attained. As it was, the parallel plots under ordinary culture gave decidedly greater yields. — (*Ibid.*, lxv.) H. P. A. [515

Fertilizers for tobacco. — Nessler has repeated part of his well-known experiments on the effect of various salts upon the quality of tobacco. The present experiments consisted of a comparison of the chloride, sulphate, and nitrate of potassium in this respect, as well as of a few other fertilizers. The results were essentially the same as those previously reached: the sulphate and nitrate improved the burning qualities, while the chloride, except in one case, caused them to deteriorate. The chloride also increased the percentage of chlorine in the ash. The author recommends applying phosphatic and potassic fertilizers to the preceding crop, and only nitrogenous fertilizers directly to the tobacco. — (*Landw. vers. stat.*, xxix. 309.) H. P. A. [516

Glutamin in beet-juice. — In an earlier investigation, Schulze and Urich obtained glutaminic acid and ammonia by boiling beet-juice with hydrochloric acid, and from this fact concluded that the juice contained glutamin, a substance which had then never been prepared. Schulze and Bosshard have now succeeded in preparing glutamin from beet-juice. The juice is first treated with lead acetate. The filtrate from this precipitate is treated with mercuric nitrate, and the resulting precipitate decomposed by means of hydrogen sulphide.

Glutamin crystallizes from aqueous solution in fine, white, anhydrous needles, soluble in hot water and dilute alcohol. It is readily decomposed by acids or alkalies into glutaminic acid and ammonia, the decomposition taking place gradually, even in the cold or on simple boiling with water. Consequently ammonia cannot be determined in vegetable extracts containing glutamin, either by Schlösing's method or by boiling with magnesia. — (*Ibid.*, xxix. 295.) H. P. A. [517

GEOLOGY.

Correlation of Cambrian rocks. — Mr. Charles D. Walcott, of the U. S. geological survey, has recently reviewed the great Cambrian sections of North America. He defines the Cambrian as the formation characterized by the 'first fauna' of Barrande.

In New York, on one side of Lake Champlain, near Chazy, the formation is constituted by the Potsdam and calciferous; and the biologic transition to the Silurian, as represented by the Chazy, is abrupt. In Nevada there is a gradual passage from the Potsdam fauna to the Silurian; and beneath the Potsdam are rocks containing the Olenellus fauna. In northern Arizona the section exhibited by the Grand Cañon of the Colorado shows at bottom the Grand Cañon and Chu-ár groups, which contain barely fossils enough to characterize them as early Cambrian. These were greatly eroded before the deposition of the Tonto with a profuse fauna equivalent to that of the Potsdam. The Silurian is absent, and the Devonian rests on the Tonto. In Wisconsin the Potsdam is underlain unconformably by the faunaless Keweenawan, and overlain conformably by the Silurian. In Vermont the Potsdam rests on the Georgian group containing the Olenellus fauna. In Tennessee the upper Cambrian is represented by the Knox shale, and the lower by the Chilhowee sandstone and the Ocoee conglomerate. In New Brunswick the St. John's group, and in Massachusetts the Braintree argillites, exhibit the Paradoxides fauna. At the Straits of Belle Isle the section is not continuous, but appears comparable with that of Nevada. The anomalous relations reported at Point Levis, in Canada, are attributed to error in the interpretation of the stratigraphy.

The Tonto group of Arizona and the Knox group of Tennessee are recognized by Mr. Walcott as the equivalents of the Potsdam of New York, Vermont, and Wisconsin. The Olenellus horizon of Nevada is correlated with the Georgian group of Vermont. The Grand Cañon and Chuar groups of Arizona are provisionally correlated with the Keweenawan of Wisconsin, and are regarded as older than the Georgian. The St. John's group of New Brunswick is held to be older than the Georgian, and probably younger than the Keweenawan and Chuar. The Chilhowee and Ocoee groups of Tennessee are provisionally assigned to the horizons of the Georgian and St. John's.

The paper marshals the stratigraphic evidence only, leaving the paleontologic to form the subject of a future communication. — (*Phil. soc. Washington; meeting* Nov. 24, 1883.) [518

PHYSICAL GEOGRAPHY.

Influence of climate on vegetation in Alaska. — In his remarks on glaciers in Alaska, Mr. Thomas Meehan remarked, that, on the top of what are known as 'totem-poles' in some of the Indian villages, trees of very large size would often be seen growing. These poles are thick logs of hemlock or spruce, set up before the doors of Indian lodges, carved all over with queer characters representing living creatures of every description. These inscriptions are supposed to be genealogies, or to tell of some famous event in the family history. The poles are not erected by Indians now, and it is difficult to get any connected accounts of what they really tell. At a very old Indian village, called Kaigan, there are a large number of these poles, with few, or, in some cases, no carvings on them, among many which are wholly covered; and these all had one or more trees of Abies sitkensis growing on them. One tree must have been about twenty years old, and was half as tall as the pole on which it was growing. The pole may have been twenty feet high. The roots of the tree had descended the whole length of the poles, and had gone into the ground from which the larger trees now derived nourishment. In one case the root had grown so large as to split the thick pole on one side from the top to the bottom; and this root projected along the whole length, about two inches beyond the outer circumference of the pole. Only in an atmosphere surcharged with moisture could a seed sprout on the top of a pole twenty feet from the ground, and continue for years to grow almost or quite as well as if it were surrounded by soil. He had seen a bush of Lanicera involucrata which was of immense size as compared with what he had seen in Colorado and elsewhere. The plant was at the back of an Indian lodge, and beside a pathway, cut against the hillside. The stems near the ground were as thick as his arm, and the whole plant was covered with very large blackberries. Stopping in admiration to look at and admire the specimen brought numbers of Indians to see what was the subject; and these smiled indulgently on being made to understand that only the sight of a huge bush had attracted the travellers' attention. — (*Acad. nat. sc. Philad.; meeting* Nov. 6.) [519

BOTANY.

(*Fossil.*)

Australian coal flora. — A memoir prepared with great care by Rev. J. E. Tenison-Woods is valuable to science, not only for the clear and detailed description of the fossil plants, but for the discussion upon the geological distribution of the coal-bearing measures of Australia.

The first notice in regard to the Australian fossil flora was given by Prof. Morris in 1845. In 1847 McCoy gave an elaborate paper on the flora and fauna of the rocks associated with the coal of Australia, and came to the conclusion that a wide geological interval probably occurred between the consolidation of the fossiliferous beds underlying the coal, and the deposits of the coal-measures, as he found no real connection between them, and as they were referable to widely different geological systems.

In 1848 Rev. Mr. Clarke dissented from the above conclusions, maintaining that there is no break whatever between the various beds containing the remains of plants described. His assertion was based upon his own discoveries, and the researches of Jukes and Dana.

After recording the long discussion between McCoy and Clarke, the progress made on the subject by Daintree, Feistmantel, etc., the author gives a clear exposition of the Australian coal-formations, as far as they are known at the present time, considering not only the remains of plants and animals found in connection with the strata, but the composition of the measures, and the localities where the strata have been examined. He gives the formations in the following series: —

1. Upper Devonian, with three species of plants.
2. Lower carboniferous, six species, among them three of Lepidodendron.
3. Permian (?), five species, among them two of Glossopteris.
4. Newer coal, trias (?) (Newcastle), fourteen species; of these, seven of Glossopteris, of which Glossopteris Browniana is most common, and also found in No. 3.
5. Rhaetic.
6. Upper lias (?), with two species.
7. Jurassic, with twenty-two species.

In recording the plants and their distribution, the author describes ninety-three species: twenty-seven are new. The plates are photographs of specimens. The remains of plants are very indistinctly and insufficiently represented. — (*Proc. Linn. soc. N. S. Wales*, viii. 37.) L. L. [520

ZOÖLOGY.

Reconstruction of objects from microscopic sections. — Born gives an elaborate description of his method of modelling, which is really very simple as well as ingenious. The sections are made with great care, all of the same thickness: they are next drawn with the camera, and the outlines transferred to wax plates, the thickness of which is chosen so as to correspond in relation to the thickness of the sections, as do the outlines to the superficial dimensions of the sections; or, in other words, each wax plate is cut out so as to represent the actual section equally magnified in all three dimensions. — (*Arch. mikrosk. anat.*, xxii. 584.) C. S. M. [521

Preservation of soft tissues. — Dr. Benjamin Sharp called attention to Prof. Semper's mode of preparing dried specimens of soft animals, and exhibited a couple of snails as illustrations of the admirable results of the process. The tissues are first hardened by being steeped in chromic acid, which is afterwards thoroughly washed out in water. The specimen is then allowed to remain in absolute alcohol until the water is perfectly extracted, when it is placed in turpentine for three or four days. It may then be dried and mounted. Specimens prepared in this way retain their characters in a very satisfactory degree, and are strong and flexible, the examples shown resembling kid. If the surface be treated, after drying, with a solution of sugar and glycerine, the natural colors will be restored; but the specimens must then be kept in hermetically sealed glass cases to preserve them from the dust. The objection to this mode of treating large specimens is the expense of the absolute alcohol: otherwise there is no reason why the largest animals should not be preserved by this process. — (*Acad. nat. sc. Philad.; meeting* Nov. 21, 1883.) [522

Preservation of protozoa and small larvae. — Hermann Fol recommends an alcoholic solution of ferric perchloride to kill small animals without injury to the tissues. It is diluted with water down to two per cent, and then poured into the vessel holding the animals. These then sink to the bottom. The water is poured off, and seventy per cent alcohol substituted. Change the alcohol, and add to the second dose of it a few drops of sulphuric acid: otherwise the iron may remain in the tissues, and cause them to overstain with coloring-reagents. The alcoholic washing should be thorough. Even larger animals (medusae, Doliolum, etc.) may be perfectly preserved by this method. The tissues may be subsequently stained by adding a few drops of gallic acid (one-per-cent solution) to the alcohol containing the specimens. The nuclei are stained dark, the protoplasm light brown, in twenty-four hours.

Fol also describes some new injection masses, which offer the advantage that they may be readily kept without spoiling. — (*Zeitschr. wiss. zool.*, xxxviii. 491.) C. S. M. [523

Fossils of Pachino. — The Marquis de Gregorio has published a brochure of twenty-five pages on the fossils of this locality. They comprise cretaceous forms of the horizon of Hippurites cornucopiae, and tertiary species of the horizon of Carcharodon megalodon Ag. The work is in octavo, and illustrated by six excellent phototypic plates representing corals, echinoderms, and a few mollusks. Simpulorbites, a new genus of Foraminifera allied to Orbitolites; Escharopsia, a new genus of Polyzoa; and Proteobulla, a form represented by casts, recalling Buccinulus, but with three strong horizontal plaits on the column, — are described and figured. — W. H. D. [524

Mollusks.

Spicula amoris of British Helices. — Charles Ashford contributes an interesting and comprehensive paper on the 'darts' found in connection with the reproductive apparatus in certain Helices. The dart is contained in a short ventricose pouch opening into the lower part of the vaginal tube, a little above the common vestibule, on the right side of the neck. There is usually one: if two are present, the second sac is on the opposite side of the tube from the first. The sac may be simple, or bilobate. At the bottom of the cavity of the sac is a conical papilla, which serves as a basis for the dart, which is attached to it by its posterior end. The apparatus is a development of adult life, and especially of pairing-time, but is indifferently present or wanting in species otherwise closely allied. The dart itself is a tubular shaft of carbonate of lime, tapering to a solid, transparent, sharp point, enlarging at or toward the base, where it assumes the form of a subconical cup. The sides of the shaft are sometimes furnished with blade-like longitudinal buttresses, which serve to strengthen it. They are rapidly formed, may be secreted in six days, and differ in form in different species. They are supposed to serve the purpose of inducing, by puncture, the excitement preparatory to pairing. They are too fragile to do more than prick the tough skin of these mollusks, but sometimes penetrate the apertures of the body, and are found within. A new weapon is formed after the loss of the old one. It is best extracted for study by boiling the sac in caustic potash. — (*Journ. conch.*, July, 1883.) W. H. D. [525

Shell-structure of Chonetes. — John Young, in the course of an examination of C. Laguessiana Kon., finds on the ribs a series of wide-set tubular openings, perhaps bases of spines, which do not extend to the interior of the shell; also a row of very minute close-set pores, placed along the central line of each rib, but which disappear after descending a very short distance into the shell-substance; a series of raised tubercles, which appear on the interior surface of the valves arranged between each pair of ribs in single rows, and which send rather distant tubules obliquely outward and backward as far as the middle layer of the shell; lastly, in the thickened cardinal edge of the ventral valve, corresponding to the spines with which it is ornamented, a series of tubes which open with round orifices on the interior, and which converge toward a point near the apex of the beak, but at the surface are continuous with the hollow of the tubular spines which point away from the beak in a direction nearly at right angles with their previous course. In a note on this communication, Mr. Thomas Davidson mentions that in Chonetes plebeia, tenuicostata, sarcinulata, and the Devonian C. armata, Mr. Young finds no trace of the external perforations described above in C. Laguessiana, although small perforations or tubules extended nearly to the middle shell-layer from the interior of the valves, slanting toward the beaks. In Productus (with a doubtful exception in the case of P. mesolobus), also, Mr. Young finds the perforations extending only part way from the interior, and never visible on the unabraded external surface of the shell. The same fact has been determined by him for the genera Strophomena and Streptorhynchus. — (*Geol. mag.*, Aug., 1883.) W. H. D. [526

VERTEBRATES.

Mammals.

Aortic insufficiency and arterial pressure. — Both Rosenbach and Cohnheim have stated that sudden insufficiency of the aortic valves, produced artificially, has no effect on arterial pressure. Goddard, on the other hand, from experiments made upon rabbits, says, that after perforation of the aortic valves, there is an important fall of pressure. De Jager has repeated these experiments, using both dogs and rabbits. Upon dogs he finds that perforation of the valves has little or no effect on arterial pressure; whereas, with rabbits, a considerable and permanent fall of pressure is the result. It appears from these experiments that the compensatory power of the heart-muscle is greater in the dog than in the rabbit, although de Jager thinks that the results may be partly explained by the fact that the injury to the valves in the case of the rabbits was generally more extensive than in the case of the dogs. — (*Pflüger's archiv*, xxxi. 215.) W. H. H. [527

Structure of the placenta. — Ercolani has renewed the advocacy of his views on the mammalian placenta, according to which, after conception, the mucosa of the uterus falls off, and a new cellular decidual layer is formed, and after delivery the mucosa is re-formed. ports some new observations, particularly on the dormouse and on woman, by which he endeavors to strengthen his position. He writes in the form of letters addressed to Prof. Kölliker at Würzburg. Dr. H. O. Marcy, in the *New York medical journal* (July 28 – Aug. 4), gives an account of these letters, but adds nothing original. The difficulty as to Ercolani's views is threefold: he leaves in obscurity the exact histolytical and histogenetical changes in, 1°, the assumed shedding of the mucosa; 2°, the appearance of the new-formed decidua; 3°, the regeneration of the mucosa. For the present, Kölliker's view, that the maternal decidua is the metamorphosed mucosa, has at least an equal claim for acceptance with Ercolani's theory. — (*Rendic. accad. sc. ist. Bologna*, Jan. 28, 1883.) C. S. M. [528

Touch-corpuscles and other nerve-endings in man and apes. — W. Wolff has investigated the corpuscles of touch in Cercopithecus, the chimpanzee, and man. The corpuscles are essentially the same in all. They have an oval form, and are distinguished by having the connective-tissue envelope thrown into folds parallel with their long axis, the folds being delicate and close together. The content of the capsule is a granular, coherent fluid. According to Wolff, the supposed nerve-filaments seen in gold preparations are really precipitates formed in the folds of the capsule.

The author questions whether the nerves have any terminations in epithelium. His principal objection is, that, if the cornea of small animals is macerated for several hours in weak gold solutions, the epithelium falls off as a distinct membrane. Now, as gold fixes the nerves, if any filaments ran to the membrane, they would hold it down, and the epithelium would not separate. The author confuses fixing the optical form of the nerves and fixing their coherency. There is no reason against, but, on the contrary, many reasons for, assuming a maceration of the nerve-filaments in weak solutions of gold. In view of the very numerous positive observations of nerve-endings in epithelia, Wolff's argumentation is weak, and it appears unnecessary to follow his further deductions; viz., that since glands are modified epithelia, and epithelia have no nerve-endings proper, therefore the gland-cells have no nerve-endings. Such attempts to set aside a vast body of evidence on account of a few imperfect observations ought not to be countenanced. — (*Arch. anat. physiol., anat. abth.*, 1883, 128.) C. S. M. [529

The action of digitaline on the heart and blood-vessels. — The authors of this paper, Donaldson and Stevens, have made a careful and thorough study of the action of digitaline on the heart and blood-vessels, and have arrived at results differing from those usually accepted. The evidence obtained by previous investigators is summarized by them as follows: "Investigations on the frog's heart show an increase of work; investigations on the arterioles have led to contradictory results, with the weight of evidence in favor of a constriction." In their own work they made use of frogs and terrapins. The heart was completely isolated from the rest of the body, and kept alive by defibrinated blood supplied to it from the venous side; while the outflow of blood from the ventricles, in the method used, could easily be determined at any time, and the relative amount of work done by the heart, when pure blood or blood containing digitaline was fed to it, estimated. The conditions under which the heart worked were made, as far as possible, the same as those existing during life. The result of these experiments was that digitaline causes a decrease in the work done by the heart. On the other hand, digitaline injected into the living animal in moderate doses increases the blood-pressure. This increase of blood-pressure cannot be caused by the heart: it must result, therefore, from a constriction of the arterioles. Experiments were made in which the arterial system was supplied with normal salt solution at a constant pressure, and the outflow collected from the large veins emptying into the heart. The heart was thus excluded from the problem. It was then found, that, when digitaline was added to the circulating liquid, there was a diminution in the outflow from the veins; and this diminution could only be caused by a constriction of the arterioles. The result of their work, then, is that digitaline causes a decrease in the work done by the heart, but increases mean blood-pressure by constricting the arterioles. — (*Journ. of physiol.*, iv. 165.) W. H. H. [530

(*Man.*)

Cilia in the human kidney. — That a large portion of the renal tubules in cold-blooded vertebrates is ciliated has been known for some time. It has also been known, from the observations of Bowman and others, that the neck of the Malpighian capsule in mammals is ciliated. A. H. Tuttle found, from the examination of a large number of sections of human kidneys, that the convoluted tubule is very extensively, if not generally, ciliated. Where the flat lining-cells of the capsule approach the neck, they become cuboidal and ciliated also. The cilia in the kidney are from 3.5 to 5 μ long, very fine, numerous, and closely set. Confirmatory observations were made on the kidney of a kitten. The cilia are probably present in all mammalia, and serve to propel the urine outwards or towards the ureter. — (*Stud. biol. lab. Johns Hopk. univ.*, ii. 453.) C. S. M. [531

ANTHROPOLOGY.

Man's place in nature. — One hears now and then the assertion that man is not the highest animal. In proof of this assertion, it is urged that this animal is far more specialized in one direction, and that animal in another. Mr. Lockington takes the ground that specialization is not in itself any proof of advance. Now, the real progress is not to be sought in the specialized offshoots of any series, but in the growing stem from which it is parted. The highest specialization is that based upon perfection of the greatest number of parts, not upon the great development of one part at the expense of others. "We need not ask morphologists or embryologists whether man is the highest animal: we have the proof of it every hour before our eyes. His powers of mind are the resultant of his structure, and have enabled him to conquer all other beings in the struggle of life. That animal is highest which possesses the widest range of faculties. This man undoubtedly does. No other animal has the power, by voice or pen, to exaggerate or depreciate its own importance; no other animal can use the powers of nature as he; no other can produce works which are proportionately comparable to his: and if, therefore, morphology or embryology contradict the facts of life, then are those sciences unsafe guides, as they certainly are only partial ones." — (*Amer. naturalist*, Oct.) J. W. P. [532

Notation of kinship. — In the study of kinship many schemes of graphic representation have been devised. A perfect system should exhibit three ideas: It should, 1. Identify each place in the series; 2. Classify kindred for each people; 3. Exhibit affinity or marriage, as well as kinship. Mr. Francis Galton presents us with a new scheme, identifying the members of the series and sex, in which arithmetical notation takes the place of letters or pictographs. — (*Nature*, Sept. 6.) J. W. P. [533

Curare. — M. Couty has made extended observations and experiments on the curare poison, and has given the benefit of his studies in a course of lectures in the museum of Rio Janeiro. The investigation closes with a modest confession of ignorance. "The *curare*," says M. Couty, "demands fresh physiological studies to comprehend the nature of its relation to the muscles and the nerves, and also the real significance of the various phenomena of excitement and paralysis which it occasions, before we should attempt to comprehend the intimate mechanism of its intoxicating influence." — (*Rev. scient.*, 1882, 587, etc.) J. W. P. [534

Color-words in the Rig Veda. — Geiger wrote, 'The men of that time [of the Rig Veda] did not and could not call any thing blue.' Mr. Edward W. Hopkins reviews the deductions of Geiger, and not only questions the facts adduced by him, but also doubts whether his application of the statements be admissible, even if proved to be facts. The use of color-words is not unlike that in other poetic literatures. Mr. Hopkins concludes: 1°. Non-mention of the colors green and blue is not proved for the Rig Veda literature; 2°. That the sky is not called blue, nor the fields green, rests on reasons which have nothing to do with the development of the retina; 3°. We cannot admit that either color-words or color-perception of those who composed the Rig Veda were inexact or imperfect; for the cause of the apparently inexact employment of words lies in the variable and uncertain color of the objects to which the color-terms are applied.

If the Vedic literature fail to support the theory of the late development of the color-sense, one of the strongest of the negative proofs is withdrawn; and even the absence of certain colors in Homer may be deemed, perhaps, of less significance than has been claimed when we consider that the Niebelungenlied exhibits, twenty centuries later, the same absence of corresponding colors, and a like ratio in the greater use of terms denoting red and yellow. — (*Amer. journ. phil.*, iv. 166.) J. W. P. [535

The Yuma linguistic stock. — In the year 1877 Mr. A. S. Gatschet brought together in two papers all that was then known with reference to the Yuma stock of languages spoken around the mouth of the Colorado of the west. Recently he has come into possession, through the Bureau of ethnology and private correspondence, of new and important material, and has been compelled to publish an appendix to his former papers. This consists of information respecting the names and characteristics of the tribes belonging to this stem; comparative vocabularies of the Yavapai, Ni Mai, and the Seri; the Yavapai vocabulary of Dr. W. H Corbusier; and the Tonto vocabulary of Dr. John B. White. — (*Zeitschr. ethnol.*, xv. 123.) J. W. P. [536

The tempering of bronze. — No doubt, native copper attracted the attention of primitive man before any of its alloys; but the difficulty of working it for a long time prevented its general use. How the metal came to be associated with tin in various forms is entirely unknown to us. Arms and implements of bronze in Egypt, Greece, and Gaul, present a constant proportion of tin, — twelve per cent. The bronze of cannons is eight to eleven per cent; of bells, twenty to thirty per cent. Recently, at Réalon (Hautes-Alpes), a peddler's pack of bronze objects has been unearthed, showing eighteen per cent of tin.

The founders of prehistoric times seem to have had three methods of procedure: —

1°. The alloy was poured into a mould of stone or metal in two pieces. The ridge formed by the junction was afterwards hammered down.

2°. A model of wood was pressed upon a layer of sand in a box, to obtain a negative of one side: a corresponding operation gave a mould of the other side. The two boxes fitted together completed the mould. There were still seams requiring to be hammered.

3°. A model of wax was surrounded with soft clay. The clay was then heated to harden it and to melt the wax. The metal was introduced at the opening left for the escape of the wax.

Soldering was unknown to the men of the bronze age: mending was done by riveting. The art of softening bronze was known to the ancients. Proclus says (Works and Days, line 1842) that "in ancient times men used bronze in cultivating the ground just as they use iron now; but that copper being soft in its nature, they hardened it by immersion." Eustathius also says (Iliad, book I., line 236) that they tempered the bronze when using it in place of iron. The chemist Darcet, at the end of the last century, showed: 1. That pure copper, heated to redness and plunged into cold water, is neither hardened nor softened; 2. Bronzes having only tin alloy, and that less than thirty per cent, heated and cooled in air, become weak and brittle; 3. The same bronzes, heated and cooled in water, are softened, and become very tractable.

It is nearly certain that the men of the bronze age tempered their implements in taking them from the mould. Those destined to stand a blow were left in this state. Arms and tools needing more temper were heated over, and cooled in the air.

Another prehistoric art, rediscovered by the engineers of Alexandria, and recently again brought to light from the orient, is rendering bronze flexible. This property of flexibility is certainly possessed by some very ancient specimens. The engineer Philo, who lived in the century before our era, describes, in his 'Treatise on artillery,' the fabrication of springs of bronze needed in some of his machinery.

The author from whom the foregoing notes are taken, A. de Rochas, will soon publish, through Masson at Paris, a volume on the origin of industry, and the first application of the sciences. — (*Rev. scient.*, Sept. 22.) J. W. P. [537

Seamy side of the Vedas. — Max Müller tells us in his recent work, 'India, what it can teach us,' that in the Vedas we have a nearer approach to a beginning, and an intelligible beginning, than in the wild invocations of Hottentots and Bushmen. Mr. Andrew Lang holds the mirror up to this assertion by showing that a highly civilized people are farther from the beginning in their religion than races which have not evolved nor accepted society. Again: there is nothing particularly wild in some of the invocations of the Bushmen (*Cape monthly*, July, 1874), nor of the Papuans (*Journ. anthrop. inst.*, Feb., 1881). Compare the prayer of Odysseus to the Phaeacian king. And, finally, the faith of Vedic worshippers was very near akin, in the wildness of its details and its mythology, to the faith of Bushmen and Hottentots. In the Rig Veda human sacrifice has left its traces, the practice enduring in symbols and substitutes which point back to something 'nearer the beginning.' The ninetieth hymn of the tenth book of the Rig Veda tells how all things were made out of the limbs of a giant, Purusha. A similar legend is found among Scandinavians, Iroquois, Egyptians, Greeks, and Tinneh. It would be easy to show that Vishnu, in the shape of a boar bringing up the world from the waters, is equivalent to the North American coyotes and muskrats performing the same feat. The origin of species from Purusha is matched only by the metamorphoses and amatory pursuits of Zeus, Kronos, Demeter, and Nemesis. Indeed, we seem to have a nearer approach to a beginning in the Vedic hymns, in those very portions in which they resemble the primitive philosophy of Bushmen and Navajos. The gods in the Vedic religion are deified nature; and we frequently see gods in animal form fighting with animals, afraid of enemies, behaving like the half anthropomorphic, half theriomorphic deities of the Australians, Hottentots, and Bushmen. The gods are begotten of heaven and earth, and are not necessarily immortal. The birth of Indra is very similar to that of Heitsi-Eibib, the supreme god of the Hottentots; and some of his feats have parallels in Scandinavian, Thlinkit, Murri, and Californian myths. Speaking of the other Vedic gods, Mr. Lang quotes the language of Racine respecting the deities of the Greeks: "Burning was too good for most of them. . . . If any one wishes to see at a glance how much savage thought persisted till the age of the Brahmanas, let him compare the myths of the constellations (*Sacr. books of the east*, xii. 282) with the similar myths in Brough Smyth's 'Aborigines of Victoria.' Except upon the hypothesis that the Aryans came civilized into the world, they must have descended from savage ancestors. That they retained savage practices, such as human sacrifices, and much worse things, is universally admitted. Why should they not have retained savage ideas in religion and mythology, especially as of savage ideas Aryan mythology and religion are full to the brim?" — J. W. P. [538

Anthropology at Berlin. — The organ of the Berlin society of anthropology has just completed its fifteenth year, and contains matter of interest not only to the local but also to the general student. Part iv. opens with a paper by Ernst Bötticher on the analogies of the Hissarlik finds. Dr. Schliemann's 'owl-faced' vases are characterized as *canopus* vases, and thus connected in type with the various art productions of Egypt, in which the bird-face predominates. The ornamentation of funereal urns with a bird-face, — be it that of a falcon, owl, or sparrow, — and the occurrence of the same custom from the Baltic to the Nile banks, are worthy of remark. Until historic evidence clears up the subject, the learned must move their opinions back and forward in the alternation of independent evolution and social contact. —— Prof. Arzruni reviews the jadeite and nephrite discussion, quoting and criticising the writings of Meyer, Damour, Janettaz and Michel, Fischer, Beck, and v. Muschketow. The author carefully excludes from the discussion minerals which have been confounded with those above named, and also mentions the fact that they have different characteristics in different localities. In Europe, up to this time, neither jadeite nor nephrite has been found *in situ*. Prof. Arzruni closes his paper with the citation of those localities in each continent which have furnished the minerals or their products. —— M. Kulischer speaks of the handling of children and youth upon the lower culture steps. He broaches a very ingenious theory, which seeks to include infanticide and all sorts of torture and ordeals in a common category of helping the survival of the fittest. In savagery, intimates the author, two children are as many as the parents can raise: they knock the surplus on the head. They subject their sons and daughters to frequent vigils, fastings, fatigues, and pains, mourning for them meanwhile as dead. Indeed, many die under the treatment, but the fittest survive. Very many scraps of information, gathered here and there, are brought within the range of the author's theory. In this connection, one should not fail to consult Ploss: 'Das kind in brauch und sitte der völker.' —— Mr. Aurelius Krause read a paper upon the relationships existing among the peoples of the Chukchi peninsula. Are the coast Chukchi and the reindeer Chukchi the same people? —— In speaking of the 'footsteps of Buda,' — a gigantic track found in the ruins of the most hallowed shrine of Buddhism at Gaya, in southern Bihar. — M. Grünwedel calls to mind, that in every part of the world are to be found, in solid rock, impressions made by the feet of gods and heroes. —— Gen. von Erckert sends to the society from Petroosk measurements of the weight, length of body, and length of limbs, taken from Russian peoples, — Wotjaks, Great Russians, Little Russians, Volga Tartars, Meshtsheraks, Poles, Bashkirs, Tscheremis, and Jews. — (*Zeitschr. f. ethnol.*, xv. pt. 4.) J. W. P. [539

The London anthropological institute. — The unlimited resources of British anthropologists lead one always to expect something good from the journal of the institute. The first paper in the current number is by F. Bonney, on some customs of the aborigines of the River Darling, New South Wales. Mr. Bonney resided on a sheep-range from 1865 to 1880, and therefore knew the Bungyarlee and Parkungi tribes 'before they were spoilt by civilization.' The aboriginal population, owing to periodic droughts of great severity, could never have exceeded 100 on an area of 2,000 □ m. Epidemics also have told upon the people. There is a typical similarity among all Australian aborigines; but, to a close observer, each tribe has its own peculiarities. The oft-repeated statement that they are the lowest type of humanity is a libel. Mr. Bonney describes their parturition customs, systematic infanticide, child-rearing, initiation of youth, class-marriage, courtesy, charms, sucking-cure, diseases, blood-cure, burials, and mourning. —— Mr. Tremlett writes of stone circles in Brittany, by which is meant two concentric rings of rude stone masonry, covered by a mound. One, called Nignol, was undoubtedly a cremation mound; since, exterior to the outer circle, cinerary urns were found, as well as between the walls. The inner circle consisted almost entirely of ashes and charcoal. Two others were similarly constructed, — one at Coët-a-touse, the other at Kerbascat. —— The subject of group-marriage is reviewed by Mr. C. S. Wake, and an attempt made to show its origin. The author assumes two fundamental rights, — the individual, or sexual; and the tribal, or self-protective. The origin of the Australian four-class division is to be sought in the separation of the original marrying group into two grades, a parent and a child grade. —— Major H. W. Fielden exhibited a series of South African stone implements. —— The Rev. James Sibree, following up the investigations of Col. Garrick Mallery, U.S.A., reports a number of gestures from Madagascar as a contribution to the study of comparative sign-language. —— Mr. A. W. Howitt reports some Australian beliefs, commencing with a delightful paragraph or two on synonymy, which we should like to quote. The superstitions described relate to the physical universe, the human individual here and hereafter, and Ghost-land. —— On the 19th of June a special meeting was held at the Piccadilly hall, by invitation of Mr. C. Ribeiro, who exhibited five Botocudo Indians and a collection of implements. —— Mr. A. H. Keane read a paper on the Botocudos. Their home is the province of Espiritu Santu, in Brazil; their name, probably from the Portuguese *botoque* (a barrel-plug), alluding to their labrets. The Tembeitera, or lip ornament, and the immense ear-plugs, give rise to an extended notice of the geographical distribution of these objects. The Botocudos are of Guarani stock physically, although of non-Guarani speech. Their physical characteristics are elaborately set forth by Mr. Keane, and extended references made to their culture, sexual relations, dwellings, industries, tribal organization, burials, religion, and language. — (*Journ. anthrop. inst.*, xiii. no. ii.) J. W. P. [540

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Geology. — Mr. J. S. Diller, an assistant of Capt. C. E. Dutton, who has charge of the investigation of the volcanic rocks in the division of the Pacific, made a geological reconnaissance of the Cascade Range, during the early part of the season, in exploring the eastern side of the range; going as far north as the Dalles, and thence to Portland, finally coming down on the west side to Red Bluff, California. He and his party travelled some twenty-five hundred miles. They were unable to do any topographical work on account of the smoke, which also interfered with the work of Mr. Gilbert Thompson (chief topographer of the California division) in the neighborhood of Mount Shasta.

Paleontology. — During the past season Mr. Charles D. Walcott received at the office, for the use of the National museum collections, a series of typical specimens, representing seventy-eight species described by Mr. U. P. James, from the Hudson River group in southern Ohio. These are the gift of Mr. James, and have been recorded. Mr. Walcott has also received, from Cornell university, for study and illustration, the type specimens used by Prof. C. F. Hartt, in Dawson's 'Acadian geology,' in his descriptions of the fossils of St. John, N.B. All the species described by Professor Hartt will therefore now be illustrated for the first time.

Prof. O. C. Marsh, in charge of vertebrate paleontology for the survey, has had parties working in Wyoming during the past season, and also in the Jurassic of Colorado, and reports to the director that they have made large additions to the collections, and very important discoveries, the results of which will be reported later.

Chemistry. — The chemical division of the survey will hereafter occupy the laboratory of the U. S. national museum, where work will be begun at once on material that has been accumulating in the hands of the chief chemist, Prof. F. W. Clarke.

Professor Clarke has been appointed honorary curator of mineralogy in the U. S. national museum. At the New Haven laboratory, Dr. Carl Barus and Dr. William Hallock are conducting thermo-electric investigations. They find that thermo-electric couples containing nickel behave anomalously at temperatures above 400° C., but that couples of platinum, with palladium or iridium, are available for the measurement of high temperatures. With such couples, temperatures as high as 1200° may be measured as exactly as with the air-thermometer.

Fresh-water shells from the paleozoic rocks of Nevada. — The bed of calcareo-argillaceous strata containing this unusual fauna is situated near the base of the great lower belt of carboniferous limestone of the Eureka mining district, Nevada. The argillaceous layers pass into calcareous strata above, that contain a few plates of crinoidal columns, and fragments of brachiopods, and besides these a fauna of forty or more species that is purely marine, and closely related to that of the lower carboniferous fauna of the Mississippi valley.

Although there is now a large collection of material from the band containing the fresh-water shells that was collected subsequent to the geologic field-work, during which the specimens now to be mentioned were collected, it will not be studied until after the publication of the report on the Eureka district. This brief notice is to call attention to the occurrence of fresh-water shells in the paleozoic rocks, and also to state that more is to be presented when the paleontologic collections shall have been thoroughly worked over and studied.

The first species discovered was a Physa, — a form of the genus so characteristic that there is no need of making any other generic reference; judging, of course, from the shell, and not presupposing that any variation existed in the animal inhabiting it. For this species I have proposed the name Physa prisca (fig. 2). The second is a species so Ampullaria-like that a reference is made to that genus (fig. 3). The operculum is shelly, calcareous, concentric (fig. 3*a*). If not generically identical with Ampullaria, it certainly belongs to the group in a closely allied genus. The name Ampullaria? Powelli is proposed for it. The third species is a pulmonate shell that appears to be closely related to Auricula, and for which the name Zaptychius carbonaria (*nov. gen. et sp.*) is proposed.

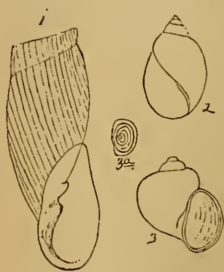


FIG. 1. — Zaptychius carbonaria × 5. FIG. 2. — Physa prisca × 2. FIG. 3. — Ampullaria? Powelli × 2. FIG. 3*a*. — Operculum of A.? Powelli.

A small lamellibranchiate shell that may be a Nucula, Corbicula, or Cyrena, probably one of the two latter, is associated with the above, and also fragments of twigs and small cones that may be referred to the Coniferae. The land-shells thus far described from the paleozoic series are all referable to the sub-order Geophila or terrestrial pulmonates, and comprise six species; viz., Pupa vetusta, P. Bigsbyi Dawson, P. vermilionensis, Dawsonella Meeki Bradley, Zonites (Conulus) priscus Carpenter, Anthracopupa ohioensis Whitfield (from the horizon of the coal-measures), and one species (Strophites grandaeva Dawson) from the erian plant-beds of St. John, N.B. To these we now add two species of the Limnophila (Physa prisca and Zaptychius carbonaria), and one species of an operculated fresh-water shell (Ampullaria? Powelli). It may be said of these species, as Principal Dawson has said of Pupa vetusta, they are remarkable not only for their great antiquity, but also because they are separated by such a vast interval of time from other known species of their race.

CHARLES D. WALCOTT.

PUBLIC AND PRIVATE INSTITUTIONS.

Williams college, Williamstown, Mass.

The natural-history department. — Through the liberality of friends, the college has secured a permanent table, with the necessary facilities for its use, in the museum of the U.S. fish-commission at Wood's Holl. The table will be occupied every summer by the department. The college has also leased for a series of years a table at Professor Dohrn's international zoölogical station at Naples, from the use of which it is hoped that permanent benefits will inure to this department. The conditions of the gift of the late Dr. William J. Walker make provision for a scientific expedition every fourth year.

NOTES AND NEWS.

THE extensive collections of American Coleoptera made by the late Dr. J. L. LeConte, containing an immense number of original types, become the property of the Museum of comparative zoölogy at Cambridge, Mass.

— We reproduce by photo-engraving, from *The photographic news*, a cut prepared from nature by the Luxotype process of the English firm of Brown, Barnes, & Bell. It should be mentioned that considerable clearness has been lost in the reproduction on account of the fineness of the stipple in the original, and the acknowledged hasty printing of the *News*. *The photographic news* has given during the last few months a number of separate imprints from plates made by processes similar to that of Mr. Ives of Philadelphia; that of Sara Bernhardt, in the issue for Nov. 23, being possibly the most satisfactory. Any one interested in the advances in the methods of making relief-plates for printing with type will find much in this series of articles of great interest. The portrait of Dr. LeConte, in this number of SCIENCE, was made by the Ives process, no hand-work having been used in the preparation of the plate from a photograph.

— While we are prosecuting our researches among the mounds, shell-heaps, and pueblos, of our own territory, we must not forget the thorough work going on in India under the patronage of the British government. For about ten years, an archeological survey of the ancient cave and rock-hewn temples of western India has been in operation, and, previously to the present year, three handsome quartos, profusely illustrated, have been published. The third volume treated more especially of the cave-temples of India.

During the present year, volumes iv. and v. have been issued, and complete the report of the survey, extending from 1876 to 1880. These volumes are about the size of the Smithsonian contributions, and are printed on fine paper, and elegantly bound. In volume iv. are forty heliotype plates and twenty-five woodcuts, and in volume v., sixty-one plates and eighteen woodcuts. It is not necessary here to enter into a minute description of these temples, since that has been done by Mr. Fergusson and Mr. Burgess, in their 'Cave-temples of India,' published in 1880. The method pursued is purely technical, "enabling the architect and the student to form a tolerably correct idea of the style and character of the plans and ornamentation. The facsimiles and translations of the inscriptions will afford fresh materials of a trustworthy character for the epigraphist and philologist." The principal group of rock-temples of western India is the magnificent series at Elura, consisting of splendid representatives of the three classes, Baudha, Brahmanical, and Jaina cave-temples. The village of Elura is in the Nizam's territory, about fourteen miles west of Aurangâbâd. Of this group, M. Baudrillart says, "All commentary grows pale before these magnificent ruins. Here the development of the plastic arts and of public religious luxury amongst the Hindus receives the most striking attestation in the magnificence of these temples, in the infinite diversity of their details, and the minute variety of their carvings."

— The Ottawa field-naturalists' club held the first *soirée* of their winter course on Thursday, Dec. 6, when the president, Dr. H. B. Small, delivered his inaugural address. After remarks on the past operations of the club, and suggestions as to its future management, he gave an excellent summary of past and present systems of the classification of the animal kingdom. The necessity of a knowledge of this character was strongly urged, in order that a just conception might be obtained of the relations of the different members of our fauna, and narrowness be avoided by those pursuing special studies. In his opinion, many persons who commenced the study of natural history abandoned it after a short time solely because, through ignorance of the relations of various objects, they failed to become imbued with that love of nature which the more carefully educated student possesses. An interesting discussion ensued on the address, in which several members shared. His excellency the Marquis of Lansdowne, governor-general of Canada, has consented to become patron of the club.

— At the annual meeting of the Boston zoölogical society, held Dec. 4, 1883, the following officers were elected for 1884: president, F. C. Bowditch; vice-president, F. H. Brackett; secretary, R. Hayward; treasurer, A. C. Anthony; librarian, H. Savage.

— In the Iowa weather bulletin for November, attention is called to "The most beautiful phenomena of the entire month. . . the varying and brilliant tints of sunset during the last five days of the month." These brilliant sunsets seem to have been noticed over the whole country.

The prediction is made, that "the winter now beginning will probably be a moderate or mild winter for Iowa and the adjacent parts of the northwest. The observations of the past ten years make the above probability very high, and, taking into account the entire series of forty years' observations, the chances for this winter proving a severe one are less than one in twenty."

— One of the most excellent of the familiar British museum catalogues is that lately published of the Batrachia, Gradientia, and Apoda, in the British museum, by Mr. George A. Boulenger. This work is called a 'second edition' of the catalogue of the same animals, published in 1850, by Mr. John Edward Gray; but it is a second edition only in name, as very little of Gray's work remains in it. The material studied by Boulenger (comprising ninety-seven of the one hundred and thirty-three species recognized, instead of forty-three) is far greater than that at Gray's disposal, and the character of the work done by the younger author is far higher.

The classification adopted by Boulenger agrees in many respects with that of Professor Cope; but some of the families and genera adopted by the latter are here given lower rank. The commonly accepted rules of zoölogical nomenclature are carefully followed by Mr. Boulenger, who evidently does not consider his own whims or prejudices, or even the traditions of the British museum, as forming a law higher than the law of priority.

Among the changes of current nomenclature considered necessary by Mr. Boulenger, we may note the substitution of the generic name 'Molge Merrem' for the later 'Diemyctylus' or 'Notophthalmus,' for our common red or green newt or 'evet;' of 'Cryptobranchus Leuckart' for the 'hellbender,' instead of the later 'Menopoma;' and of the name 'Necturus maculatus Raf.' for the 'mud-puppy,' instead of 'Menobranchus' or 'Necturus lateralis.'

An instructive discussion is given of the geographical distribution of the Batrachia, the geographical divisions with that group coinciding very closely with those recognized in the distribution of the fresh-water fishes.

— The Society of naturalists of the eastern United States will hold its second meeting at Columbia college, New-York City, Dec. 27, at ten A.M.

— Gen. Richard D. Cutts, first assistant superintendent of the U. S. coast-survey, died at Washington, Dec. 13, at the age of sixty-six. Gen. Cutts was born in Washington, and was connected with the coast-survey the greater part of his life. During the war he served on the staff of Gen. Halleck.

— On the 25th and 26th of October, there fell at Hilo, Hawaii, $17\frac{15}{100}$ inches of rain in twenty-two hours, by rain-gauge.

— The December number of *Van Nostrand's engineering magazine* contains an announcement, that, as the publication of the magazine has continually entailed a loss, the magazine will not be continued after the coming year, unless an increased support should justify it. That a magazine of such great merit should succeed is most heartily to be wished.

… SCIENCE.

FRIDAY, DECEMBER 28, 1883.

THE CHIEF SIGNAL-OFFICER'S REPORT.

The report proper of the chief signal-officer of the army for the year ending June 30, 1883, has been published in advance of the complete volume, which will contain the usual appendices. When compared with those of previous years, it presents a marked and most gratifying contrast. The useless and tiresome repetition of much that has appeared regularly since the organization of the service is no longer indulged in; and, in fact, the present report is brief, fresh, and vigorous. It is pleasant to see, that, among the various topics discussed, the first place is given to 'Instruction in meteorology.' Although somewhat crippled by lack of sufficient appropriation, this work has not been allowed to retrograde; and the encouraging fact is noted, that, out of a hundred and seventy-two enlistments made during the past two years, fifty-three were college graduates.

Gen. Hazen argues ably and pointedly against the inadequate provision made by the last Congress. The separation of the signal-service from the army proper, as far as its support from the general appropriation goes, undoubtedly left the service in a worse condition, even, than was intended by those who sought to reduce its expenditures. The result has been, that a number of stations have necessarily been closed, and much important work of the weather bureau has been suspended. It is certainly to be hoped that it may receive more generous treatment at the hands of the present Congress.

An interesting *résumé* of the scientific work of the weather bureau is given, which indicates a commendable activity in that direction. One of the most important announcements is, that a new standard of thermometry has been adopted "which no longer agrees with that of the Yale college observatory, but approaches more nearly to that of the International bureau of weights and measures." Another is, that steps have been taken to inaugurate in the immediate future a series of elaborate observations upon atmospheric electricity. The continuation of the publication of 'Professional papers' by members of the scientific corps is noted, one of the most important of which is that on 'Movements of the atmosphere,' by Professor Ferrel. It is gratifying to observe throughout the report, that scientific meteorology is receiving a recognition to a degree much greater than formerly.

A brief history of the unfortunate Greely expedition is presented, and the statement made that it is intended to apply for an appropriation to enable another relief expedition to be sent out in 1884.

The report covers twenty-two pages, instead of three or four times that number, as was the case in previous years; but, as a report of progress for the year, it is much more valuable than its predecessors. A similarly judicious treatment of the appendices and meteorological summaries, which will follow this report, would bring the whole into a much more useful and manageable form, and would not be the least important of the many reforms introduced into the service by its present chief.

ROMALEA MICROPTERA.

Should the return of spring be early, and the winter just passed an open one, a rambler in the meadows of southern Louisiana is very likely, during the middle of February, or perhaps even earlier, to have his attention drawn to curious little colonies of red and black grasshoppers.

These are the young of Romalea microptera. Until this summer I never saw a living adult specimen of this handsome insect, and my examination of it had been confined to a few individuals in alcohol. No sooner, however, had I thoroughly examined one of these little red and black colonists, than it struck me that they must be the young of the great black grasshopper I had seen in spirit. This was subsequently confirmed for me through the kindness of Mr. L. O. Howard, of the Agricultural department at Washington. One day last March, during the first part of the month, while on one of my collecting excursions in this country, my way lay through an extensive cypress-swamp. The only good footing was along a low, straight embankment, that had been made by the earth thrown out to dig a canal, to which it now formed the bank on one side. It was composed of a dry, black soil, upon which the new spring grass and the earlier plants had just commenced to make their appearance. It was here that I first came across a family, or brood rather (for no old ones are to be found at this time of the year), of the young grasshoppers in question. They extended obliquely across my path in nearly a straight line, about half a yard in length, and from three or four to a dozen or more individuals in width. Where small dry twigs occurred, or blades of grass, in their course, they completely covered them, and were so packed together that in some parts of the group they crowded each other a good deal. When first discovered, little or no activity among them was apparent; but no sooner did I commence to lay in a store of specimens than the survivors of my attack immediately began to hop off in all directions, obliging me very soon to make single captures. At this stage of their growth, these insects are about of the same size, having an average length of a centimetre; their general color being a deep, shiny black. This is set off by fine lines of brilliant vermilion, occurring at different places on the body. One strip extends mesiad, the entire length of the dorsal aspect, from a point between the antennae to the posterior extremity of the abdomen; another bounds, on either side for a short distance, the hinder margin of the prothorax; while the same is found behind the whole length of each of the hind-femora. The lower and posterior angle of the epicranium is also bordered by the same color as is its inferior margin in front, and a line that extends down from the eye on either side to join it. Finally we observe that each abdominal ring is emarginated in the same way, along the ridges of the pleurite portions, below the spiracles. At this age the antennae are half as long as the body.

A few weeks later, when they are about double the size I have just described, we begin to observe in these collections, which are apparently all of the same crop, some specimens considerably larger than the general run. These may be females, but this I cannot positively assert: though, as the insect grows, these larger ones maintain their size over the others; and later in the year we find them to be females, notwithstanding the sexes at these times seem to be pretty equally divided in numbers.

In the middle of June, a field in the vicinity of New Orleans, where the grass had grown to be about waist-high, was covered in one or two places of no great extent with these grasshoppers. They now ranged from four to five centimetres in length, and could be seen at several hundred feet distance. Other varieties of plants were covered with them; but I found none on the ground, unless they were accidentally knocked down, or jumped down when one failed in his efforts to capture them.

At these times they are very sluggish, emitting no sound or note that I ever heard, and do not seem to be feeding on the vegetation upon which they congregate. Their colors are now somewhat changed; and, though the black is as deep and shiny as ever, the red gradually fades to a brilliant orange, and a small pair of dull black wings commences to make its appearance.

In the country about New Orleans, Romalea seems to attain its full growth some time in the early part of July. This is denoted by the general appearance and habits of the insect: certain parts of his exoskeleton have become firm and hard, and all his structures and organs bear evidence of maturity. They are no longer found in groups in the meadows and forests, but dispersed, and occurring in all sorts of localities. Hundreds of them are found invading the cow-paths and roadways: others climb on fences and trees. Many still are yet observed, though now usually singly, on high grass and plant-stalks; and these we may easily discern at a long distance in the open fields. Even our houses are not altogether exempt, at this season, from this black-mailed vagrant. Many are killed by being trodden upon, or accidentally crushed in other ways; for they are slow to get out of one's road, and disinclined to jump much, — a feat in which the males, from their lighter weight, far exceed the larger and heavier females.

It is about this time of the year that we first begin to notice any thing approaching an *affaire d'amour* on the part of this now truly handsome insect. We now see many couples apparently regardless of those who behold their awkward and highly fantastic addresses. The only sound that I have ever heard this grasshopper give vent to, is now indulged in by the male. It consists simply of a series of peculiar hisses (this word expresses it better than any thing else), and is only heard when we seize and handle one of them, or during their mating. The sound seems to be produced largely by the wings; for these members are elevated at this time, as I have shown them in my plate, where the male exhibits his beautiful hind-wings, — a relief to his otherwise sombre tints that is only to be experienced on such occasions.

I am of the impression that Romalea does not confine itself to any particular diet, but is rather a general feeder, choosing such plants as happen to fall in its way. Some of them, that I kept alive for several days in a large box, fed upon almost any thing in the shape of vegetable growth that I offered them.

This view seems to be sustained by the report of Mr. L. O. Howard, who saw them in August in immense numbers in the rice-fields about the city of Savannah; 'yet they seemed to do little damage to the rice.' [1]

This observer tells us in the same report, that they are known in that locality among the people as the 'lubber grasshopper,' whereas, throughout this section of the country, they are called by every one the 'devil-horse.' Perhaps, if at one of their grand councils they had a choice in the matter, it would be hard for them to decide which was the prettier name, and no doubt they would vote unanimously to select some other one.

It has never been my fortune to find examples of the black variety of the female in southern Louisiana, as observed by entomologists elsewhere.[2]

On the 28th of last July, while engaged in looking for a specimen of the prothonotary warbler, which I had just brought down with my cane-gun from a magnolia under which I stood, my attention was attracted by a large female Romalea, with part of her abdomen buried in the ground, and evidently in the act of depositing her eggs. A chapter in the history of this insect at once flashed across my mind; and, in my undue eagerness, I removed her at once from the little excavation she was in on the ground; but the most careful search afterwards was not rewarded by the discovery of a single egg. However, the satisfaction was afforded me, at the subsequent *post mortem* of the specimen in question, of finding her ovaries containing upwards of fifty bright-yellow, spindle-shaped eggs, each about a centimetre long.

[1] Report commiss. agric., 1881–82, p. 138. [2] *Ibid.*, p. 138.

This circumstance convinced me that Romalea microptera deposits its eggs in the ground; and from that time I did not allow an opportunity to slip in searching for them. My interest in this matter was only increased by receiving a letter, a few days afterwards, from Mr. Howard, in which he informed me that it was not known where this grasshopper laid its eggs. I am sorry to say that I have not had the opportunity to examine the reports made by Glover upon this insect, in the report of the Department of agriculture for 1872, kindly called to my attention by my correspondent, nor the mention made of it in Ashmead's 'Orange insects,' also referred to by him.[1]

My search was, however, afterward rewarded; for on the 15th of August, while passing through a long, flat meadow a few miles from New Orleans, I came, at one end of it, to a little low mound about ten yards in extent, composed of a dry black earth, that was cracked and fissured in many directions by a sun that streams down here almost as mercilessly as in the tropics. Many tall weeds and grasses surrounded this miniature hillock, and others grew upon it.

Romalea had made this elevation its headquarters, and it was at the same time a rendezvous for many couples who had apparently postponed their honeymoons. The importance of the occasion was evident; for there was not a male on the ground, to say nothing of the majority who were perched up in the weeds, but was strutting about in the most business-like manner, or trying to do so on their perches in the latter. Whatever part of the entertainment these sable gentlemen entered into, they constantly kept up a very audible buzzing racket with their wings, which they elevated and lowered at few seconds' intervals, showing the inferior carmine pair each time they did so, with telling effect. At these times they assume the position in which I have drawn one in the plate, walking about in a stilted manner, but bearing, withal, a dignified mien, rattling their wings, and paying their court to the quieter and more sedate opposite sex.

Some of the females kept apart, and bore the appearance of being dejected, tired of the gayeties of the season, and otherwise bored by the proceedings that were going on everywhere about them. It was the sight of these satiated dames that soon brought the thought to my

[1] I have since ascertained that Mr. Charles R. Dodge, of the Agricultural department of Washington, has raised the young of Romalea from eggs that were laid by specimens he kept in confinement. He published his observations in the *Rural Carolinian* (April, 1874, p. 363, vol. v., no. vii.), Charleston, S.C.; and subsequently in the *Field and forest* (ii. 1877, p. 160), Washington, D.C.

mind, that perhaps they laid their eggs here too; and acting immediately upon this, as well as the suggestive fissures in their camping-ground caused by the sun, I proceeded to investigate those likely places in which they might deposit their ovicular treasures. These rents presented every stage of being filled in from one cause or another; and I had hardly commenced to scratch out the earth from one that was partially in this condition, than I came across masses of their eggs. They were not easily observed at first, as I turned them out with the stick I used in searching for them, from the fact that they resembled lumps of earth, as this substance adhered to their entire surface, either dusted over, or in little fragments, which latter rendered the resemblance still more deceptive. My plate represents one of these masses, that has been well cleaned off, in the lower right-hand corner (marked *A*). I have four before me that were collected at the time of my observations, and one of these is that figured in the plate.

The first of these masses that I pick up contains about thirty-five eggs, of a like size and shape to those removed from the body of a female several weeks before. They are in one rather irregular layer, being placed roughly parallel to each other, and entirely incased by the pellets of earth that have adhered to the mass. No true egg-pod was observed to enclose them; but, judging from the way in which the eggs of other large grasshoppers are laid, no doubt further observations will prove its existence. The eggs of this lot are all sound, and in an apparently safe condition till the time of hatching, as they were several inches below the surface of the ground. In the next collection the mass is of a circular form, with the eggs arranged pretty much as we found them in the first lot. Here, however, they are quite distinct, being simply dusted over with a little earth; and I find several of them have been opened at the sides, and their contents removed, apparently by ants or other insects. The two remaining masses are essentially of the same description as those we have just described. One is a little different in shape, being oblong instead of circular. This form may have been forced upon it from the narrowness of the fissure in which the eggs of this lot were laid. Of these four deposits, we may say that they contain an average of thirty eggs apiece; and this statement, no doubt, will be very near the correct one for the usual number found in such masses.

Examining one of these eggs under a two-inch objective, we find it composed of an outer coat, brown in color, fibrous in texture, and about 0.1 of a millimetre in thickness. The little fibres are placed side by side, and vertical to the surface of the egg. This coat fractures off in small pieces quite easily, and, in so doing, exposes the thin membranous and transparent inner coat, which allows one to see through it the amber-colored contents of the egg proper, which are of a viscid character and of about the consistency of old olive-oil.

This was the only occasion upon which I ever succeeded in finding any of the eggs of this grasshopper; and I am unable at the present writing to say how many times they deposit during a season, or how often Romalea moults during the same period.

It was my intention, when I commenced this paper, to enter to some extent upon the anatomy of this insect; but the idea was eventually abandoned from the fact that the anatomy of locusts and grasshoppers has been very ably and extensively worked up by many entomologists: so, to enter upon this subject at all in the present case would entail a minute study of details and comparisons that would result in carrying my paper much beyond its intended limits. Then, too, so far as the external appearance of Romalea is concerned, I have made every effort to convey a correct idea in my plate, both of the male and the female; and this work has been most carefully and beautifully reproduced by my engravers, Messrs. T. Sinclair and Son of Philadelphia, — a firm to whom our scientific men are under so many obligations for faithful reproductions of their work. This sketch, in its present form, then, is offered to the readers of Science as a contribution to the life-history of Romalea microptera; and it is hoped that in it at least a few facts will be discovered that will prove of interest to entomologists.

R. W. Shufeldt,
Captain Medical corps, U.S.A.

RESOLUTIONS OF THE INTERNATIONAL GEODETIC COMMISSION IN RELATION TO THE UNIFICATION OF LONGITUDES AND OF TIME.

The seventh general conference of the International geodetic association held at Rome, and at which representatives of Great Britain, together with the directors of the principal astronomical and nautical almanacs and a delegate from the Coast and geodetic survey of the United States, have taken part, after having deliberated upon the unification of longitude by the adoption of a single initial

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ROMALEA MICROPTERA

meridian, and upon the unification of time by the adoption of a universal time, has agreed upon the following resolutions: —

1°. The unification of longitude and of time is desirable as much in the interest of the sciences as in that of navigation, of commerce, and of international communications. The scientific and practical utility of this reform far outweighs the sacrifice of labor and the difficulties of re-arrangement which it would entail. It should, then, be recommended to the governments of all the interested states to be organized and confirmed by an international convention, to the end that hereafter one and the same system of longitudes should be employed in all institutes and geodetic bureaus, for general geographic and hydrographic charts, as well as in astronomical and nautical almanacs, with the exception of those made to preserve a local meridian; as, for instance, the almanacs for transits, or those which are needed to indicate the local time, such as the establishment of the port, etc.

2°. Notwithstanding the great advantages which the general introduction of the decimal division of a quarter of the circle in the expressions of the geographical and geodetic co-ordinates and in the corresponding time-expressions is destined to realize for the sciences and their applications, it is proper, through considerations eminently practical, to pass it by in considering the great measure of unification proposed in the first resolution.

However, with a view to give satisfaction at the same time to very serious scientific considerations, the conference recommends, on this occasion, the extension, by the multiplication and perfection of the necessary tables, of the application of the decimal division of the quadrant; at least, for the great operations of numerical calculations for which it presents incontestable advantages, even if it is wished to preserve the old sexagesimal division for the observations, for charts, navigation, etc.

3°. The conference proposes to governments to select for the initial meridian that of Greenwich, defined by a point midway between the two pillars of the meridian instrument of the observatory of Greenwich; for the reason that that meridian fulfils, as a point of departure for longitudes, all the conditions wished for by science, and because, being at present the best known of all, it offers the most chances of being generally accepted.

4°. It is suitable to count the longitudes, starting from the meridian of Greenwich, in the sole direction from west to east.

5°. The conference recognizes for certain scientific wants, and for the internal service in the great administrations of routes of communication, — such as the railways, steamship-lines, telegraphic and post routes, — the utility of adopting a universal time, along with local or national time, which will continue necessarily to be employed in civil life.

6°. The conference recommends as the point of departure of universal time and of cosmopolitan dates the mean noon of Greenwich, which coincides with the instant of midnight or with the commencement of the civil day, under the meridian situated twelve hours, or a hundred and eighty degrees, from Greenwich.

It is agreed to count the universal time from 0 hour to 24 hours.

7°. It is desirable that the states which, with a view to adhere to the unification of longitudes and of time, find it necessary to change their meridians, should introduce the new system of longitudes and of hours as soon as possible.

It is equally advisable that the new system should be introduced without delay in teaching.

8°. The conference hopes, that, if the entire world agrees upon the unification of longitudes and of hours by accepting the meridian of Greenwich as the point of departure, Great Britain would find in this fact an additional motive to make, on its part, a new step in favor of the unification of weights and measures by adhering to the *Convention du mètre* of the 20th of May, 1875.

9°. These resolutions will be brought to the knowledge of the governments, and recommended to their favorable consideration, with an expression of a hope that an international convention — such as the government of the United States has proposed — for confirming the unification of longitudes and of time should be decided upon as soon as possible.

ORIGIN OF THE MESODERM.

The origin and composition of the mesoderm has been the subject of perhaps more discussion than any other single point in the whole range of embryology. Observers have given the most conflicting statements, for the most part due to incomplete observations; but now we are at last in a position to eliminate many of the false descriptions and to harmonize fairly well those we must regard as correct.

The first important advance was accomplished by His, who made the fundamental discovery that the mesoderm is not homogeneous, but double, in its origin. The ectoderm, entoderm, and part of the mesoderm, he distinguished under the common name of 'archiblast,' from that portion of the mesoderm which is related to the connective-tissue group (connective tissue proper and endothelia), and which he supposed to grow from the yolk (in the chick) into the archiblastic tissue or cells, which, from the first, are constituent elements of the embryo. His maintained that the parablast-cells were derived from the white elements of the yolk, but in that respect he is believed to be in error; nevertheless to His belongs the great honor of having first insisted upon the duplex development of the middle germ-layer. This knowledge is the key to the solution of one of the fundamental problems of animal morphology.

The researches of Professor His have been confined to vertebrates. One cannot but feel that his views would have been modified in many details, if he had included the lower types, also, in his investigations. The discoveries of others, however, have gradually made it clear that among invertebrates, also, the twofold composition of the mesoderm exists. The path to this generalization may be said to have opened out upon the announcement by Alexander Agassiz that in echinoderms the lining of the body-cavity and water-vascular system is derived from the entoderm. Selenka and others have since shown that the rest of the mesoderm is derived from scattered and isolated cells, which are thrown off from the other layers into the space between the ectoderm and entoderm. It was thus clearly shown that in this class of animals the mesoderm primitively consists of two epithelial evaginations and of scattered and independent cells of amoeboid character. The fundamental importance and the far-reaching significance of this discovery were unfortunately not appreciated at the time.

For several years past I have been accumulating materials for a work on 'Comparative histology,' and have meanwhile directed my attention chiefly to the classification and genesis of tissues. These preliminary studies led me to various conclusions, among which was the conviction that amoeboid cells were the primitive representatives of the mesoderm, and that from them was derived a large part of the mesodermic tissues. This view I published in 1879;[1] but the article has, so far as I am aware, been entirely overlooked by subsequent writers, and I therefore venture to call especial attention to it now, as the opinion I then advocated has since become a current embryological generalization. To the cells I gave the name of 'mesamoeboids.'

The investigations of Hatschek, whose brilliant discoveries have not yet received their deserved recognition, have revealed that in Bryozoa, Mollusca, Annelida, and Amphioxus, the mesoderm arises, 1, from cells, such as we have seen may be classed under the head of mesamoeboids; 2, from two paired masses of cells, his 'mesodermstreifen,' whose origin from the entoderm is rendered probable in all cases, and certain in some, by known characteristics. These stripes either have from the first, or soon acquire, a distinctly epithelial structure. Hatschek appears to have recognized the bearing of his observations nearly as we conceive it now; and to him, I think, we should accord the honor of having first clearly and definitely recognized the dual histogenesis of the mesoderm.

F. M. Balfour, in his writings, particularly in his 'Treatise on comparative embryology,' made the next important step by pointing out that the vertebrate mesoderm probably arose as a pair of diverticula from the gastrula cavity; and he gave a new meaning to, and justification of, this theory, by insisting upon the homology between the blastopore of the Ichthyopsida and the primitive streak of the Amniota; for from the walls of the former, as well as from the substance of the latter, the paired outgrowths of the middle layer arise. The deficiency in Balfour's presentation of the subject lies in his failure to recognize the importance of the mesamoeboids.

The brothers Hertwig have published a series of contributions to the solution of the problem, and have embodied their general results in an article entitled the 'Coelomtheorie.' As we have shown, their predecessors had pretty well established the necessity of regarding the mesoderm as consisting of two parts, — *first*, the paired epithelial portion derived from the entoderm, forming the lining of the body-cavity, and giving origin to the peritoneum, muscle-plates, genital glands, etc.; *secondly*, scattered cells, giving origin to the connective tissue, the endothelia, vessels of the circulation, the blood, and lymph. These conclusions, however, had never been systematically collated and coherently presented. The brothers Hertwig performed this task with characteristic ability and success. Guided by their own important original researches on several animal types, and utilizing the results of others, they succeeded in demonstrating the prevalence of the same composition of the mesoderm in the

[1] Minot: Preliminary notice of certain laws of histological differentiation. *Proc. Boston soc. nat. hist.* xx. 207.

majority of animals. Their own most important addition to our knowledge appears to me to be their analysis of the morphology of muscular tissue, by which they removed the most important difficulty against the final acceptance of the generalization. While we thus recognize the great services rendered by the brothers Hertwig, we are impelled also to express our regret that they have not been more generous in their acknowledgment of the achievements of previous investigators; for their theory was mainly the result of a judicious combination of what had been before published. To them belongs the merit of ripening the fruit which was already formed.

To the mesamoeboid portion of the mesoderm the Hertwigs gave the very appropriate name of 'mesenchyma.' For the epithelial portion no satisfactory name has yet come into use: therefore I venture to propose 'mesothelium.'

In applying this generalization which we have been considering to vertebrates, difficulties and objections were encountered. To set these aside, Professor Oscar Hertwig has published two special researches, the second of which appeared recently, and is reproduced in abstract below.

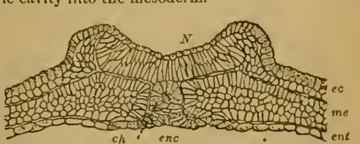
In this review, only a few salient points of the history of this most important of recent embryological discoveries are given; but I cannot close without a strong expression of my regret at being unable to notice many valuable contributions to the subject, — a pleasure which the limited space at my disposal compels me to unwillingly forego.

In continuation of the extended researches on the origin of the mesoderm previously given to the world by his brother and himself, Oscar Hertwig now publishes the results of his investigations on the development of the middle layer in the frog, adding a discussion of its origin in other vertebrates. The early stages in the frog are described with great minuteness, and with far less concision and directness than we should have anticipated in any of Professor Hertwig's writings.

The essential points brought forward are the following. In the first stage, while the blastopore still appears as a round white spot, the primitive *darm* (urdarm) has the well-known form. Its inferior and lateral boundaries are the cells of the entoderm; but along the dorsal line the cells offer a different histological character, being pigmented, and consisting of three or four rows of small cells. In Triton, however, there is a single row of high cylinder cells. This dorsal band includes the *anlage* of the notochord, and is named by Hertwig 'chorda-entoblast.' Around the blastopore the mesoderm is already present, forming a paired extension running forward as a lateral mass on either side, and a median division lying below the blastopore. Around the edges of the blastopore all the layers are united: throughout the remainder of its extent the mesoderm is separated by a narrow space from both ectoderm and entoderm. The mesoderm and the chorda-entoblast are both histologically similar to the ectoderm; and Hertwig, on that account, believes they are both derived from the outer germ-layer. (This conclusion we think is founded upon an insufficient basis.)

In the next stage the blastopore remains merely as a white point, and the medullary folds and median dorsal furrow appear. The notochord is developed under the dorsal furrow as a thickening of the median portion of the chorda-entoblast, which butts against the ectoderm, so that the mesoderm is excluded from the axial line. Ultimately the lateral portion of the chorda-entoblast enters into the formation of the intestinal wall; but in Triton the whole of this peculiar band is changed into the chorda, which, being formed by an invagination, exhibits a slit in transverse sections of early stages. No such slit is seen in frogs. There is a fold formed at the lateral junction of the chorda-entoblast with the rest of the entoblast; and along that fold the entoderm is fused, without demarcation, with the mesoderm. Around the blastopore the three layers still present essentially the same arrangement as before; the mesoderm has grown out around the whole ovum, except a small area on the ventral side, where the ectoderm and entoderm (yolk) are in immediate contact.

In the next stage, when the whole length of the broad medullary groove is clearly marked out, and indeed in later stages also, the absolute independence of the notochord of the mesoderm, and its development out of and gradual separation from the chorda-entoblast, are to be clearly recognized (see the accompanying figure). In the region of the blastopore, where the mesoblast is continuous with the other layers, there are two projecting lips, on one side formed by the entoderm proper, on the other by the chorda-entoblast. These lips enclose a fissure between them, which is a small evagination of the enteric cavity into the mesoderm.



Frontal section through a frog ovum in which the medullary ridges have begun to appear. *Ent*, entoderm; *enc*, chorda-entoblast; *ch*, notochord; *me*, mesoderm; *ec*, ectoderm; *N*, nervous system.

In a later stage the anus is developed *behind* the blastopore as a simple ectodermal invagination, the bottom wall of which breaks through. No such relations between the germ-layers have been found here, or elsewhere, as around the blastopore.

The points, then, of special importance, brought out by Hertwig, are, 1°, the existence of the median dorsal band of cells, the chorda-entoblast, entering into the formation of the entodermic wall, but resembling in character the ectodermal cells; 2°, the development of the mesoderm as a paired outgrowth from the blastopore. In part second of his paper, Hertwig reviews the published investigations on the embryology of other classes of vertebrates. He accepts the homology of the primitive streak in Amniota with the blastopore. He is fairly successful in proving the same relations of the germ-layers to exist in all vertebrates. He also discusses the various objections advanced against the *coelomtheorie*, according to which the mesoderm is an epithelial layer, bounding the body-cavity. He draws from his observations and arguments the following conclusions: 1. The mesoblast grows as a continuous mass from acknowledged epithelial layers; 2. In all vertebrates there early appears a fissure in the mesoderm, limited parietally and viscerally by epithelium, as can be especially well seen in elasmobranch embryos; 3. From this epithelium are derived true epithelial membranes in the adult, from which are developed the peritoneum, kidneys, sexual glands, etc.; 4. The primitive mode of origin of the mesoderm is probably that described by Kowalevsky and Hatschek in Amphioxus, —an invagination of an epithelial membrane (entoderm); 5. In the true vertebrates the mesoderm grows out as a solid mass, in which the fissure appears later. This must be regarded as a secondary modification, for we frequently find hollow organs making their first appearance as solid *anlagen;* e.g., the central nervous system of teleosts, many sense-organs, and most glands. These considerations lead collectively to the final conclusion that the mesodermic plates are morphologically epithelial evaginations homologous with those of the invertebrates.

CHARLES SEDGWICK MINOT.

ACOUSTIC ROTATION APPARATUS.

In a recent number of the *Zeitschrift für instrumentenkunde*, Dr. V. Dvořák gives an account of the various forms of apparatus which have been devised to show attraction or repulsion due to sound-waves, or to gain a continuous rotation.

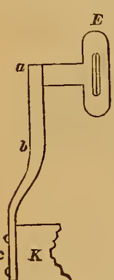


Fig. 1.

Such experiments require a good volume of sound for success. That this may be obtained, not only should the tuning-fork be in accord with the resonator-box on which it is placed (the most convenient form of sounding-body for the purpose), but also the elastic system, consisting of tuning-fork and box, should be capable of vibrating in unison with the fork and the air in the resonator. The three sounds are called the fork, the air, and the wood tone. In order to get the last, the resonator should be stuffed with cotton-wool, and a piece of cork put between the prongs of the fork; then, by rapping on the top of the fork, the whole system is vibrated very much as it would be by the up-and-down motions of the lower part of the fork when free. By cutting away the walls of the resonator to make them thinner, the system may readily be brought to the right pitch. In most of the resonators in common use the wood tone is too low, owing to the wood being already too thin.

The fork used by Dr. Dvořák was *G*, having 392 vibrations per second. It weighed 265 grams. As a resonator, an ordinary pine box was used, about 13.5 cm. long, 11 cm. broad, and 10.5 cm. high. In one side a round hole was cut, large enough to make the air tone of the right pitch. The wood was 8 mm. thick. From the top and bottom it was shaved off for the purpose explained above. The dimensions of the box were entirely accidental, but proved to be good.

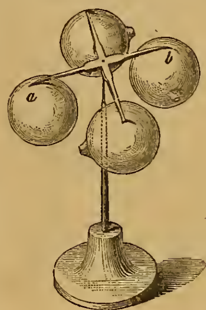


Fig. 2.

By using an electro-magnet to keep the fork in continuous vibration, the results are naturally more sure. The form of magnet which has proved satisfactory is shown in fig. 1. *E* is the magnet, with a core made of iron plates. This magnet is placed between the prongs of the fork, and is held by the wooden arm *a c*, to the lower end of which is fastened the resonator *K*. At *b* the arm is bound to a firm support, so that the system of fork and resonator is perfectly free.

The resonator-wheel (fig. 2) is the first form of rotating apparatus described. It consists, as shown in the illustration, of four glass resonators on the four arms of a wheel. For a fork of 392 vibrations, the spheres should be about 44 mm. in diameter, with openings 4 mm. across. Rotation was obtained with the fork 40 cm. away.

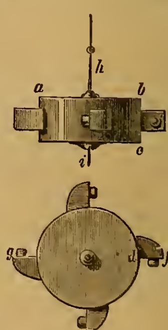
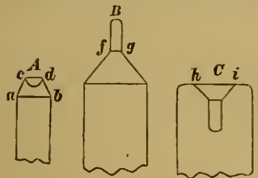


Fig. 3.

As a modification of this wheel, a rotating resonator (fig. 3) may be made of a flat cylindrical pasteboard box, having a number of side-openings, each ending in a short piece of tubing of size to make the resonator respond to the fork. When suspended by a silk thread, *h*, such a resonator can be easily put in rotation ; *i* is a needle to rest in a hole in a piece of lead, to prevent oscillation. The dimensions given are: *a b*, 70 mm.; *b c*, 36 mm.; *d f*, 19 mm. The tubing openings were 8 mm. long and 6 mm. in diameter.

The sound-radiometer (fig. 4) is readily made. In cardboard about 8 mm. thick, holes are punched at intervals of 6 mm. with the punch of the form shown at *A*. When prepared in this way, the cardboard will be repelled if presented to the resonator with the small ends of the holes toward it, and attracted when reversed. To make these effects more marked, the punch and die shown at *B* and *C* may be



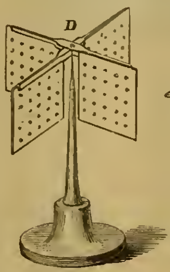


Fig. 4.

used on moistened cardboard to form conical holes with cylindrical ends. The conical holes alone show no effects. By arranging the pieces of pasteboard as in *D*, or better as in *E*, a rapid rotation may be obtained. The apparatus shown in fig. 5 is called a sound-wind-mill. A Helmholtz resonator, *a b*, is placed before the opening of the box-resonator. Out of the smaller end, *a*, a stream of air will be blown when the fork is vibrated, and its existence shown by the rotation of the windmill, *h k*. The dimensions of the Helmholtz resonator for *G* are : diameter, 80 mm. ; the opening at *b*, 16 mm. ; at *a*, 2 mm. This last is very important. It seems odd that the resonator with two openings may be replaced by such as shown at *R* with only one. The opening may face in any direction, provided the windmill is suitably placed, and still the mill will turn. When the opening is turned toward the resonator-box, the distance between the

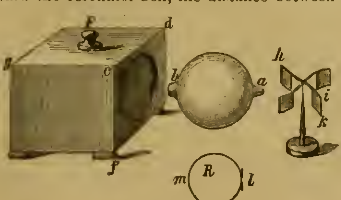


Fig. 5.

resonators may be as great as half a metre. The dimensions and form of the ball are important. A suitable one may be made by grinding off the top of a glass globe 50 mm. in diameter, and covering the opening with a very thin metal plate in which there is a hole 3.5 mm. across. The puffs of air coming from the opening *l* are vortex-rings, which may easily be shown by filling the ball with smoke.

By putting one of the wings of the sound-radiometer before the box-resonator with the larger ends of the holes facing it and at a distance of 2 cm. from it, the mill may be made to rotate by the puffs of air coming through the holes, which should be numerous.

AURORAL EXPERIMENTS IN LAPLAND.

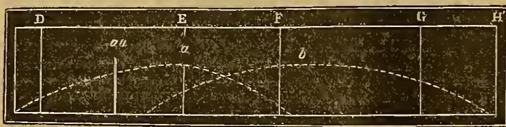
MR. J. RAND CAPRON gives a brief account (*The observatory*, Sept.) of Professor Lemström's experiments, quite similar to that which has already appeared in SCIENCE. He thinks that Professor Lemström's conclusion, that the height of auroras "has been generally over-estimated may probably open a lively discussion, as undoubtedly his dictum will that 'measurements of an aurora on a long base must be erroneous, as the observers never see the same aurora.'" He thinks, too, that the relation Professor Lemström believes himself to have proved, between movements of atmospheric electricity and the 'variations of the magnetic elements,' may be only apparent.

Mr. Capron believes that the experiments described did "collect and make apparent to the eye a true auroral glow, its spectroscopic character being at the same time tested and defined by experienced observers." He adds, "Yet one cannot help feeling something of regret that, if only for further assurance, the wave-length of some one line seen was not (as far as we are aware) absolutely determined, on some occasions at least, and that the observations appear to rest only on a small instrument presumably without scale."

Mr. Capron's article is important mainly for calling renewed attention to the phosphorescence, or fluorescence, theory of the principal (yellow-green) line of the aurora spectrum. This theory, first proposed by Angström, was advocated in the *Philosophical magazine* for April, 1875, by Mr. Capron, who is inclined to attribute the line to phosphorescence, apparently on the following grounds: 1°. The 'phosphorescent appearance' of the aurora ; 2°. The fact that phosphorescence is capable of giving quite sharply defined spectral lines, as shown by his observations with a phosphorescent vacuum tube ; 3°. The fact that the auroral line belongs to 'the principal region of phosphorescent light;' 4°. 'The observed circumstance that the electric discharge has a phosphorescent afterglow.'

Mr. Capron observed, moreover, that the auroral line lies in the region of a certain bright band in the spectrum of a phosphoretted hydrogen flame, though somewhat nearer the red end of the spectrum than is the brightest part of this band, as shown in the accompanying figure.

"In this diagram (of a normal spectrum), curve *a* [which Mr. Capron calls the phosphorescence curve] is deduced from the spectrum of phosphoretted hydrogen, curve *b* from Professor Angström's spectrum of the violet pole of air-vacuum tubes; *a u* is the principal auroral line." This figure is apparently intended



to represent the facts under ordinary laboratory conditions; but Mr. Capron states, that according to Lecoq de Boisbaudran, when the flame of phosphoretted hydrogen is artificially cooled, the bands of the spectrum become intensified, and in such a way that the brightest portion of each band is shifted toward the red end of the spectrum. Mr. Capron appears to think, that, under the intense cold of the auroral regions, one of these bands might become the line *a u*.

E. H. HALL.

LETTERS TO THE EDITOR.

Secular increase of the earth's mass.

THE thoughtful and suggestive researches of Ebelmen and T. Sterry Hunt, on the chemical and geological relations of the earth's atmosphere,[1] have led me to some further deductions, which seem to increase the interest in this field of inquiry. The general tendency of these studies is to show that the chemical transformations in progress upon the earth involve the fixation of a larger volume of atmospheric constituents than could probably have ever existed in the atmosphere at one time, and that they must consequently have arrived from interplanetary space.

1. *The carbonates.* — It is generally agreed, as first shown by Hunt, that the carbonates of lime and magnesia have arisen chiefly through the interactions between carbon dioxide of the atmosphere, the decomposing silicates of the earth's crust, and the chloride of calcium of the ocean. The carbon dioxide has therefore been contributed by the atmosphere. To what does this contribution amount? We may assume, without material error, that the carbonates here in question are all calcium carbonate, with a specific gravity of 2.72. Then, the mean pressure of the atmosphere being about 14.7 pounds avoirdupois on a square inch, a little calculation shows that an amount of carbon dioxide in the atmosphere sufficient to double its pressure would yield only 8.627 metres of limestone. An amount sufficient to cause a pressure of 80 atmospheres would suffice for the formation of limestones equal to only a fortieth (.02265) of the hundred thousand feet which, for this purpose, may be assumed as the thickness of the stratified rocks. But a pressure of 80 atmospheres at a temperature of 30° C. produces liquefaction of carbon dioxide. The actual proportion of limestones and dolomites in the earth's crust is about one-eighth, as I have shown by recent studies. This amount would yield, by the liberation of all its carbon dioxide, a pressure of 441.6 atmospheres. If we consider the limestones and dolomites formed since the period of the coal-measures, the proportion required to yield, on the liberation of its carbon dioxide, a pressure of 80 atmospheres, would be only a twenty-second (.04469) of all the post-carboniferous strata. The actual proportion is about one-eighth, as for the whole stratified crust; and this would yield sufficient carbon dioxide to cause a pressure of 223.8 atmospheres.

It is not credible that such amounts of carbon dioxide have ever existed in the atmosphere at one time. During the larger part of the aeons of carbonate formation, animal life has existed in great abundance upon the earth; and this would have been impossible with 200 to 400 atmospheres of carbon dioxide present. As the proportion of this gas in the existing atmosphere is only 4½ parts in 10,000 by weight, 200 atmospheres of the gas would be 444,000 times the present proportion. It is scarcely more credible that the pressure of 200 to 400 atmospheres would have been compatible with either vegetable or animal organization, so similar as it was fundamentally to modern organization. As this large amount of carbon dioxide cannot be supposed derived from the earth's crust, it must have been derived from interplanetary space. This would imply an addition to the earth's mass of .0003806, which is about $\frac{1}{2636}$ part of the present mass.

2. *The kaolinization of felspars.* — Hunt has shown that the kaolinization of a layer of 51.66 metres of orthoclase, or its equivalent of quartzo-felspathic rocks, would result in 23.7 metres of kaoline, and would use up 10,333 kilograms of carbon dioxide per square metre of surface. This is the weight of the atmosphere. Now, the whole amount of felspathic decomposition during the sedimentary ages must much exceed 500 metres in vertical thickness of kaolinic deposits. But 500 metres of kaoline represent 21.1 atmospheres of carbon dioxide; and, assuming the mass of the atmosphere at $\frac{1}{1200000}$ in relation to the earth, the carbon dioxide fixed in the processes of kaolinization would be .0000175826 of the total mass of the earth.

3. *Decay of hornblende, pyroxene, and olivine.* — According to Hunt, the decay of 10⅓ metres of such minerals, or their equivalents in hornblendic and pyroxenic rocks, would yield carbon dioxide equal to 1 atmosphere: hence, if the earth's crystalline rocks have afforded 500 metres of hornblende and pyroxene, they must have fixed 48.387 atmospheres of carbon dioxide. This, in relation to the earth's mass, is .0000403209.

4. *Conversion of ferrous into ferric oxide.* As Ebelmen states, the conversion of 21,357 kilograms of ferrous oxide into 23,750 kilograms of ferric oxide would consume the whole of the 2,376 kilograms of oxygen in the atmosphere (more exactly, 1.007 atmospheres) covering a square metre. If, then, we suppose the existence over the earth of 1,000 metres of sediments derived from the decay of crystalline rocks containing only one per cent of ferrous oxide, weighing, according to Hunt, 25,000 kilograms, this is 1.052 times the amount requisite to fix the oxygen in 1.007 atmospheres; that is, 10 metres of ferric oxide represent the fixation of 1.059 atmospheres of

[1] See a memoir by T. Sterry Hunt in *Amer. journ. sc.*, May, 1880, where references are given to numerous other publications.

oxygen. This, in relation to the earth's mass, is .0000008825.

5. *Unoxidized carbon.* — This occurs not only in coal-beds, but in pyroschists and petroleum. We find that the oxidation of a layer of carbon 0.7123 metre in thickness would use up all the oxygen in the atmosphere. A layer 2.252 metres thick, and having a specific gravity of 1.25, if converted into carbon dioxide, would exert a pressure of one atmosphere. This would amount to 2,267,000 tons of 2,240 pounds each on a square mile. Mr. J. L. Mott calculates that the amount of unoxidized carbon per square mile cannot be less, and is probably many times greater, than 3,000,000 tons. If we adopt this determination, it will imply a depth of 0.982 metre, and the proportion of the earth's mass will be .00000036318. This is the amount of carbon dioxide which must be decomposed to yield a layer of carbon over the earth only a trifle over three feet in thickness, while it is probable that the carbonaceous deposits of the earth's crust exceed this. Now, it will hardly be maintained that the uncombined carbon of the earth's crust was derived from any other source than the atmosphere, and mostly through the agency of vegetation. The earth's atmosphere must therefore have contained all this amount of carbon dioxide. With the fixation of the carbon, the freed oxygen, it may be said, might have been employed, as far as it would go, in the formation of ferric oxide, whose demands upon the atmosphere have just been computed; but, as it would only satisfy $\frac{1}{309}$ of those demands, it is hardly necessary to consider the question.

6. *Meteoric contributions.* — If, as commonly assumed, 400,000,000 meteors enter our atmosphere daily, an average weight of ten grains each would amount to a yearly addition of 93,170 tons. This, in 100,000,000 years, would amount to .000000001542 of the earth's mass, and would form a film .292, or nearly $\frac{3}{10}$, of an inch thick, having a density of 2.5.[1]

Gathering together these various contributions to the earth's mass during 100,000,000 years, we have the following: —

1. CO_2 represented by the carbonates . . .	.0003896
2. CO_2 fixed in kaolinization of felspars . .	.0000175826
3. CO_2 fixed in decay of hornblendic and augitic rocks	.0000403209
4. O fixed in conversion of ferrous oxide . .	.0000008825
5. CO_2 represented by uncombined carbon .	.00000036318
6. Meteoric contributions	.000000001542
Aggregate	.000439750722

This is an addition of $\frac{1}{2274}$ to the earth's mass; and, in the present state of knowledge, it does not appear on what grounds assent can be withheld from the result, or some result of similar purport. It must be left with the astronomer to determine what relation this increase may sustain to the moon's acceleration in its orbit and to other phenomena. It may be noted, however, that the remote secular recession and retardation of the moon, which G. H. Darwin has recently brought to view, would have been delayed by the cause here considered, and the time required for the attainment of the moon's present relations would have been prolonged, but to what extent remains to be determined.

The evidences disclosed by these recent researches, of the slow accession of gaseous and solid matters to the earth, possess a profound interest. It would almost seem that the earth's atmosphere is only so much of the intercosmical mixture of gases and vapors as the earth's mass is capable of condensing around it, and that the proportions of these gases are determined separately, each by its own weight and elasticity and by its relative abundance in space; so that, as any one becomes diminished by fixation in the planetary crust, new supplies arrive to keep the ratio constant. As under this view it is apparent that an atmosphere should be accumulated around the moon, even after the saturation of the pores of its rocks, it may be said that the moon's mass and volume are such that her atmosphere would possess only $\frac{1}{36}$, or, according to Neison, $\frac{1}{50}$, the density of the earth's atmosphere; and this degree of tenuity might reduce the lunar atmospheric refraction to the small value actually observed.

ALEXANDER WINCHELL.

[1] The value given for this film in a note, p. 14, in my 'World-life,' should be multiplied by 365¼.

Regulation of electromotive force.

In one of the articles — the first, I think — recently published in SCIENCE (ii. 642) upon the subject of the electric light on the U. S. fish-commission steamer Albatross, the writer tells us that the brilliancy of the Edison incandescent lamps is kept constant, when other lamps upon the circuit are lighted or extinguished, by placing an adjustable resistance in the circuit of the field-magnets of the dynamo-electric machine, 'whereby the internal and external resistances are balanced.'

The importance of the subject scarcely seems to warrant any more space being devoted to it than already has been. But the point that I bring up is not an immaterial one, such as whether the engine is on the port or the starboard side of the vessel: it is a question which involves interesting and important physical principles.

The reason an adjustable resistance is required in the field-circuit of an Edison dynamo, in order to maintain a steady incandescence of the lamps, results from the fact that the armature has some resistance. This resistance is quite small, to be sure, but it has a considerable effect, nevertheless.

In order that a multiple arc system should be perfect, so that the dynamo or generator would require no adjustment or regulation when lamps were turned on or off the circuit, it would be necessary that this generator should have absolutely no resistance: for, if it were possible to reduce the internal resistance to zero, then there would be no fall of potential within the machine itself; that is, the fall of potential would all be in the external circuit, and the difference of potential between the poles of the generator would be equal to the total electromotive force of the circuit. In that case, all that is necessary is to keep the electromotive force constant; and then it follows, that any number of the lamps in the system may be lighted or put out without producing any fluctuation whatever in the light of the other lamps, because the incandescence of a given lamp depends only upon the electromotive force with which it is supplied. Now, we know that the electromotive force generated by a dynamo is constant, provided that the speed of rotation of its armature, and the intensity of the field-magnetism, are kept constant. The armature is maintained at a constant speed because it is driven by a steam-engine furnished with a governor, the function of which is to secure a constant speed;[1] and the field-magnets have a constant strength because the current which excites them is constant, since this current, like the current in the lamps, is produced by an electromotive force, which, by hypothesis, is constant.

Let us now consider the case where the resistance of the armature is not zero (to which, of course, it

[1] The speed would remain constant, but the *power* required would increase with the number of lamps in circuit.

never could be reduced), but is some small fraction of an ohm (say, .2 ohm), and suppose that there is a single lamp of 140 ohms' resistance in circuit, and that the electromotive force is 100 volts: then $\frac{140}{140.2} \times 100 = 99\frac{6}{7}$ volts will be the fall of potential in the lamps, and only $\frac{1}{7}$ volt in the armature. But suppose that there are 70 lamps of the same resistance (140 ohms) in circuit, instead of a single one: then the external resistance will be reduced to $\frac{140}{70} = 2$ ohms, and the fall of potential in the lamps will only be $\frac{2}{2.2} \times 100 = 90\frac{10}{11}$ volts, and $9\frac{1}{11}$ volts in the armature.

Thus we see, that, when the number of lamps in circuit is increased from 1 to 70, the difference of potential available in the lamps is decreased from $99\frac{6}{7}$ to $90\frac{10}{11}$ volts, a reduction of almost one-tenth; in consequence of which the candle-power of the lamps would be lowered at least one-third, and probably one-half. Of course, variations in the brightness of the lamps of one-third, or one-tenth, or even one-twentieth, would not be permissible: therefore, in order to maintain the required steadiness of the light, it is necessary to raise the electromotive force of the dynamo as more lamps are put on, and to lower it as lamps are taken off. This is done by increasing or diminishing the strength of current in the circuit of the field-magnets by means of a resistance-box interposed in the circuit. This regulation of the electromotive force of dynamos by controlling the resistance of the field-circuit may be, and in fact has been, made automatic; but up to the present time it has more generally been done by hand.

In what has gone before, I have said nothing about the resistance of the conductors which convey the current from the dynamo to the lamps. The effect of the resistance of any conductor which is *common to two or more lamps* — one of the main conductors, for example — is precisely the same as the effect of the resistance of the armature, which has been discussed above; but when a conductor supplies only a *single* lamp, then it does not have this effect. Of course there is a loss or fall of potential due to the resistance of the individual conducting-wires of each lamp; and of course the fall of potential in the lamp itself, and consequently its brightness, are thereby reduced. But this resistance does not introduce any *irregularity:* its effect in diminishing the light of the lamps is constant.

Let us suppose that a conductor having a resistance of 140 ohms feeds a single lamp of 1.4 ohms' resistance: then the loss in this conductor will be 1% of the useful fall of potential. But suppose that we now put 10 more lamps in circuit: then the loss in the conductors will be increased to over 10%; and assuming the useful fall of potential to be 100 volts, with a single lamp in circuit, it will only be about 90 volts with 11 lamps. The candle-power of the first lamp would drop at least 25% or 30% when the other 10 lamps were added. Thus it is, that, in a multiple arc system of electric lighting, any resistance which is common to a number of lamps, whether in the armature or the conductors, causes fluctuations in the light of the lamps when other lamps are put on or off; whereas the resistance of the individual conductors of each lamp produces a loss of potential which is a constant fraction of the total potential, but does not introduce any unsteadiness.

F. B. CROCKER.

Osteology of the cormorant.

With respect to Mr. Jeffries' criticism (SCIENCE, ii. 739) of my paper on cormorants, I beg to say that the occipital style of the cormorant is not an ossification in the tendon of any muscle; that he is entirely wrong in his view of the homologies of what I call a patella; and that, furthermore, I find myself misquoted more than once.

R. W. SHUFELDT.

A dog plans and executes with reference to the future.

Six weeks ago Prof. J. B. Thayer of this place returned from Ree Heights, Dakota, bringing with him one of a litter of eight pups raised by a slut of the setter breed. The story which he relates to me of this pup's mother is, it appears to me, worthy of record.

The good mother appears to have discharged her arduous duties as only a mother can, and arrived with her eight babes at the time when they should be weaned. At this juncture, judging from the events reported to have followed, she seems to have conceived the idea that too many dogs were occupying the same claim, and that a distribution was desirable. Accordingly, she started one morning with three of her pups, and was observed by Miss Rosa Cheney, now of this place, running in the road toward their claim at a rate which made it impossible for the pups to keep pace with her. The dwelling where she lived, and another shanty on the adjoining corner of another claim, are situated one mile and three-fourths from the dog's home. The mother reached the claims in advance of her babes, but no sooner had they arrived than she hurried on at her best pace. Miss Cheney reports that "the puppies came up all out of breath, and apparently too tired to continue; but the smallest of the three followed on." Another claim was reached three-fourths of a mile beyond; and here Miss Cheney observed the mother stop until her panting babe came up, when she immediately set off again. A quarter of a mile beyond the last claim, the mother was observed to make a third halt as before, and then to pass on beyond the range of vision, towards Ree Heights, with the puppy still following her. Two days later the persistent mother, with her more persistent babe, was observed coming back; and Miss Cheney tells me that the little puppy appeared almost dead from fatigue.

Some days later the dog led off two more of her pups, and succeeded in leaving them both; but in the mean time the two puppies left the first day were returned. A pup was also left at Professor Thayer's claim, but was returned, and exchanged for another. Both Professor Thayer and Miss Cheney assure me that other efforts of the same kind were made by this dog, but with what results they are unable to say.

After the puppies had been distributed, they were not forgotten; for the old dog used often to go and play with them. Professor Thayer mentions one instance of her coming and playing with the puppy left at his claim until it was very tired, when she lay down by the side of it; but, after it had gone to sleep, she quietly walked to the opposite side of the house, and then hurried away in the opposite direction from home for a distance of about forty rods, when she turned and went directly there, thus showing quite clearly that the thought of distributing her puppies was still uppermost in her mind.

What events may have awakened this desire on the part of the mother, or what reasons she had for her acts, we do not know; but in her own mind I have no doubt the case was urgent and the way clear, if not also just. It would appear, not only that this dog must have thought her plan through, but that she must also have held it definitely in mind for several days while she executed it, thus indicating quite unequivocally, it seems to me, that one animal at least, ranked lower than man, possesses the power of looking into the future and of executing plans deliberately laid with reference thereto; "man is the only animal which has the power of looking into the future," to the contrary notwithstanding. F. H. KING.

River Falls, Pierce county, Wis.

Method for making electrical signals.

When I first became connected with the Alabama agricultural and mechanical college, the recitation signals were made by means of electric bells, one in

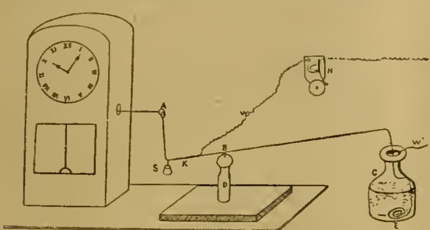


FIG. 1.

each professor's room. These were rung separately by pressing in succession as many push-buttons as there were bells. In order to complete the system, it was necessary to have one wire for each bell, and a return-wire running through the whole length of the system; and therefore only *one* bell could be rung at once. In the circuit there were twelve bells, about one-half mile of wire, and twelve one-gallon cells of Watson's battery. One of the cadets of the college was delegated to sound the signals at the end of each fifty minutes, which was the length of the recitation hours. Sometimes he would ring too soon, and at other times several minutes too late. This was frequently annoying, particularly when an interesting

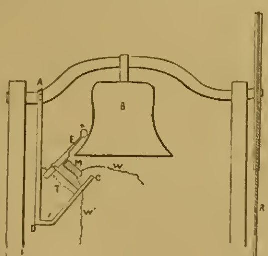


FIG. 2.

and important lecture was in progress. In the attempt to obviate this difficulty, the plan that I am about to describe was suggested to my mind.

We have an excellent compensated clock that can be made to strike twice any multiple of five minutes. After adjusting this clock so as to make it strike every fifty minutes, I insulated it on a square of plate glass. I then made an oblong opening in the side of the woodwork about one inch long. This slit was made on a line with the ball of the striker. Through this hole I passed a copper wire, and fastened it securely to the hammer of the gong. In the end of the wire outside of the clock I made a loop, as shown at *A*, Fig. 1.

A second wire, *A B C*, was attached to the first, as shown in the figure. A loop at *B* fits in a slit in the upright *D*, and a pin is inserted at *B* to hold the wire in position and at the same time allow the ends *A* and *C* to work up and down when the hammer of the clock strikes. The bottle *C E* is partly filled with mercury. From this mercury-cup a wire, *E W″*, runs to one pole of the battery. The other pole connects at *K* with the wire *W′*, after passing through all the bells of the system. *S* is a weight to counterbalance the arm *B C*. It will be readily seen that the outward stroke of the hammer will throw the end of wire *A B C* into the mercury, thus completing the circuit, and causing all the bells to ring. The blow of the hammer against the gong of the clock will raise the end *C*, and break connection. All but one of the bells must be single stroke: otherwise it will be impossible to obtain satisfactory results. By using one bell, with attachment for breaking and closing the circuit, the ringing will continue as long as the wire at *C* is in contact with the mercury.

The above system has been in operation for one year, and has given satisfactory results.

It has occurred to me that our large bell, weighing nearly two thousand pounds, can be made to strike the hours for the benefit of the town by placing it in the system just described, with the following adjustment. Procure a soft iron horseshoe magnet six or eight inches long, and secure it at *M* on the iron rod *A D C*, Fig. 2. This becomes magnetized when the clock completes the circuit. The armature *X Y* is attracted, and the ball *X* strikes the bell. The elasticity at *E* raises the ball immediately from contact, and allows a clear and distinct ring. The tension-spring *T* raises the armature from the magnet, and the current ceases to flow. If it is desirable at any time to ring the bell in the ordinary way by means of the rope *R*, the adjustment of the system may be sustained by making the supporting rod *A D C* secure to the bell-shaft at *A*, and thus permitting the magnet and fixtures to swing with the bell.

P. H. MELL, Jun.

Auburn, Ala.

GEIKIE'S GEOLOGY.

Text-book of geology. By ARCHIBALD GEIKIE, LL.D., F.R.S., director-general of the Geological survey of Great Britain and Ireland, etc. With illustrations. London, *Macmillan & Co.*, 1882. 971 p. 8°.

TEXT-BOOKS in science once held a rather low place in the estimation of scientific men. Labor of this sort was long relegated to the book-makers, who, copying statements and illustrations one from another, gave the student more of the errors of by-gone days than of the knowledge of their own. But in our own time all this has been greatly bettered. Now a man of science is likely to look forward to text-book making as a source of honor as well as of remuneration; as a task that may not only help others on their way, but aid himself to a broader and more careful view of his own field of labor. The text-books of Lyell, Jukes, and Dana in geology are among the admirable works of these great authorities, and were doubtless helpful to them in their careers, as they have been vastly advantageous to those who have been trained by them. From a purely literary point of view, text-book making has no mean value to their makers. To collect the stores of learning of a science, to take that which has general value from the mass of details, to secure a due proportion and perspective to the parts of the work, — this is a task indeed.

Mr. Geikie has proven himself strong enough for this burden. His store of facts is far larger than has hitherto been gathered in any one book on geology. They show a large general reading, not only in the vast geological literature of his own island, in the making of which he has had a large share, but in the work done in other lands, — a praise that can be given to few of his countrymen. In his list of authorities he gives more names of scientific men of other countries than of British geologists; and this although he professedly desires to take his illustrations as far as possible from his own ground.

Besides the peculiarly large amount of well-gathered fact that marks this work, we may note among its peculiarities the considerably wider range in the method of treatment of the subject. In his first book he gives twenty-four pages to the cosmical relations of the earth, and under this heading presents the fullest and most satisfactory statement of the general condition and history of the earth as a member of the solar system that has yet been given in a popular treatise. With the same freedom of treatment, he does not hesitate to give a much fuller discussion of mineral veins than has hitherto found its way into any text-book. So, too, with those portions of the text that treat of river-action, volcanic phenomena, and the other leading manifestations of the geological forces. The author evidently feels a sense of freedom in making his book that is to be commended even if it gives him in the end near a thousand pages of text.

The paleontological part of the work is carefully done, but it is in the nature of the subject that it should be less commendable than the other parts of the book. There is a radical difficulty in treating paleontology, especially in its department of historical geology, in any text-book fashion. Even within the ample limits given by a thousand pages of print it comes down to a list of specific names that can only convey a meaning to the masters of the science; while the first principle of a text-book should be, that any statement should have a free comprehensibility within itself, without recourse to libraries or collections. Page after page of specific names hinders rather than helps the beginner.

This is the only criticism that can be made on the historic geology of the book, and it is one that lies against all the text-books that have thus undertaken to treat a subject that is so essentially unfit for this use. The essays on the divisions of the rock series are admirable. Especially to be commended is that on the old dispute concerning Cambrian and Silurian. It is pleasant to find a successor of Murchison in the directorship of the British survey who can do even-handed justice to the famous dead who fought this great battle over the division of the lower paleozoic section.

At several other points in the series of rocks we find an excellent spirit of discrimination applied to the problems of stratigraphic geology. We note the following. In discussing the relations of Permian to carboniferous rocks, the author notes the important fact, that, while in Europe there are discordances and sharp contrasts between the Permian and the carboniferous series, there is no such trenchant line in America. In the same spirit the indistinctness of the line between the triassic and the Jurassic series in North America is carefully pointed out. We find, also, that the doubt concerning the position of the Flysch series of the Alps is well presented; the ground being taken that the lower part of this series is upper cretaceous, the higher portions, eocene. This is the best brief presentation of this important problem that is known to the present writer. The only important exception that we can take to this admirable presentation of the stratigraphic problems concerns the author's general treatment of the triassic period. He notes that the European triassic series, with its reddish sandstones and shales, with connected gypseous and rock-salt beds, is essentially local in character, and that this aspect of the series cannot be expected in foreign lands. To this no objection can be taken; but he fails to assert the equally important fact, that reddish sandstones and shales have a singularly wide distribution in other lands. This general character of the trias constitutes it one of the most puzzling portions of the geological section, and it should be given its due prominence in any general account of the series.

The last eighteen pages of the book are given to the chapter on physiographic geology.

This matter belongs in close relation to the earlier chapters of the book, and seems somewhat isolated in its position. It is not so completely treated as the other parts of the book; but it is, nevertheless, a fair condensation of the most material points of the subject. The illustrations of this subject are rather limited, but a diagram of the Colorado Canyon by Mr. Holmes (p. 923) gives a peculiar value to the set of diagrams.

It is hardly fair to quarrel with the title of so good a book, but it would have been better to have given it the name of a manual rather than a text-book. It is not fitted for the ordinary use of schools; being far too rich in matter, and calling for too much collateral knowledge for classroom work. It belongs in association with Dana's classic manual of geology. For American students it cannot replace that admirable book; but, taken along with the American work, it will give the student a very complete encyclopaedia of geologic science.

The book is fairly well made. The type is bolder-faced than in Dana's manual; so that the total amount of matter is about the same in the two books, despite the somewhat larger page of Geikie's volume. An admirable feature of the book is the free use of footnotes referring to authorities, which is a distinct advantage the book has for the student. The figures are well chosen, and finely serve their purpose; though there are not quite half so many as in Dana's work.

The index is voluminous and well made.

HAECKEL'S CEYLON.

Indische reisebriefe. Von Ernst Haeckel. Berlin, *Paetel*, 1883. 13+356 p. 16°.

A visit to Ceylon. By Ernst Haeckel. Translated by Clara Bell. Boston, *Cassino*, 1883. 8+337 p. 16°.

In his 'Voyage of the Beagle,' Darwin has shown that an acquaintance with nature does not in the least detract from the interest of a traveller's adventures. Haeckel, in his new book on Ceylon, has still further given evidence that a love for nature's treasures adds an indescribable charm to one's wanderings in a strange land. In the 'Indische reisebriefe' we find a charming account of a scientific pleasure-excursion which the author made during the six months following October, 1881. The journey included a brief stay at Bombay, and a much longer series of travels through Ceylon, covering a space of four months.

Upon reading the book, the first impression we get is, that Haeckel must be a most pleasant travelling-companion, so delighted is he with every thing. He starts, he tells us, on a trip he has been longing for all his life, and evidently with the expectation and intention of having a delightful excursion. Nor will he allow any thing to frustrate his intention. It makes no difference where he is, or who are his companions: his good nature is unbounded. Every one, he seems to think, treats him with more than kindness; the roads he travels are models of comfort; and even the elements conspire in his favor. The country he passes through calls forth the whole wealth of the German language to find adjectives sufficient to express his boundless admiration. Officials give him every assistance; private homes open to him with the kindest hospitality; and even the natives take great interest in him, and are ever ready to give him aid which is at least kindly intended. When he establishes his laboratory at Belligam, he is supplied with servants, to whose excellency he can only do justice by naming one Socrates, and a second Ganymede. Belligam, the name of the town where he established his laboratory, means 'sand-village.' This name, however, does not suit Haeckel's general delight; and he calls it Bella gemma, considering it as 'a choice jewel in nature's casket.' An ordinary trip in the tropics is thus, by good nature and enthusiasm, transformed into a glowing journey through fairy-land. Indeed, one almost imagines, as he reads, that he has found an American advertisement of a pleasure-excursion. So full of pleasure and good fortune is the whole trip, that the reader soon grows weary, and wishes that some slight accident might happen, to break the monotony. It is certainly a relief to find the admission that the fauna of the island is disappointing; and we are quite reconciled to the fact, that the scientific laboratory was not quite so successful as had been hoped.

Haeckel's style in this book, as indeed in all his writings, is a most happy one. He gives what may be called a confidential description of nature where it is most lovable. The reader gets the impression that it is being given him in person by the author, for the purpose of enjoying once more the pleasures of the journey, and having a quiet laugh at the people. He cannot keep himself out of his descriptions, — indeed he does not try to do so: and what we see on every page is not a picture of Ceylon, but a picture of a man, making a journey through

Ceylon. He begins by telling us that he is getting to be an old man, and it is now or never with him as regards a journey in the tropics; but when, in the next breath, he informs us that his advanced years number eight and forty, we are quite amused at his premature old age. When he tells us, in the first chapter, how the Berlin academy refused to give him any aid on account of the challenge he had thrown to it on evolutionary speculations, we laugh with him. We see his amusement as he writes upon seeing wild apes for the first time: "Comparing them with the dirty and naked begging priests at our feet, they seemed to me a highly respectable ancestry for them." His German nationality, too, is ever apparent. Now we see it when he describes his German companions, or more frequently when he delights in his allusions to 'the indispensable black tail-coat and white necktie' of old England, or to the English 'chimney-pot' (*cylinderhut*), which he considers, 'of all head-coverings, the most hideous and insufficient.' He enjoys telling of English gluttony as compared with German temperance, of the Englishman's love for money with his exorbitant prices, and finally ends with the terse statement, 'Unsonst ist in Indien nur der tod.' But even his admiration for Germany does not prevent him from giving tribute to the faculty which England has exhibited as a colonizing power.

The scientific results of the Ceylon journey are not apparent. He travelled quite extensively through the island, continually swelling his collections, and finally established a rough laboratory at Belligam, where he worked hard for six weeks, filling his large cases with specimens from land and sea. But beyond the statement that the fauna of Ceylon agrees closely with that of the Philippine and Fiji group, the zoölogist gets little scientific knowledge. His account of the botany of the island is more extensive; but even this is largely made up of artistic descriptions of the magnificent vegetation which so vividly impresses a traveller in the tropics. That the journey was made by Haeckel is, however, sufficient proof that it was more than a pleasure-excursion. He brought back large cases of specimens, of which he says little, but which will, in years to come, undoubtedly be a source of much valuable information to the scientific world.

The book is not intended to be a scientific production, but rather a pleasant account of a naturalist's travels; and as such it is a success. A book of travels is usually dry and uninteresting after the first few chapters; for, however interesting new places may be to the traveller, to keep up a novelty in description soon becomes an impossibility. Haeckel has not entirely overcome this difficulty, but he introduces variety in the shape of personal anecdotes and observations. He is successful, too, in selecting most interesting points for description; and this, together with his boundless love for nature, which is so evident in every line, makes the closing chapters of his book much less wearisome than is usual with books of like nature. He reserves his account of the people until toward the end, and thus gives a series of bright chapters as the close of his stay at Belligam; and, by the continual introduction of people and incidents, he succeeds in keeping the reader's attention better than is customary. But, in spite of all, the last chapters of the book will invariably be glanced over in a hurried and cursory manner.

The translation by Clara Bell is on the whole good, though she has evidently been hard pressed to find expressions which will translate Haeckel's superfluity of adjectives. In some cases she seems to have been unable to find English expressions which give any idea of the German. One hardly gets the idea from the phrase 'worthy and fair reader,' which is conveyed by the German, '*Du, geneigter leser, und noch mehr, vererhte leserin.*' Though she has not followed the German very closely in her translation, yet she has succeeded in conveying to the English reader a tolerably good idea of Haeckel's flowing, free, and confidential style. The wonderful success of Haeckel's writings has proved that his method of writing and dealing with scientific subjects is a most attractive one; and this edition of his visit to Ceylon, partly on account of the freedom of the translation, but more largely because of the nature of the subject treated, will give to the English reader a better idea of his style of writing than any other of his translated works.

REMSEN'S THEORETICAL CHEMISTRY.

Principles of theoretical chemistry with special reference to the constitution of chemical compounds. By Ira Remsen. Revised edition. Philadelphia, *Henry C. Lea's Son & Co.*, 1883. 242 p. 12°.

In preparing this new edition of his little book upon 'Theoretical chemistry,' Professor Remsen has extended quite materially the second part, which treats of the constitution of chemical compounds, and which forms its most distinctive and attractive feature. Many of the alterations, however, will hardly be regarded as improvements by those who believe that a clear and definite presentation of chemical theories is quite essential to their proper comprehension. While it is manifestly highly important that the student should not only be acquainted with the facts upon which chemical theories rest, but should also appreciate fully the nature of conclusions reached by inductive reasoning, still a constant reiteration of the doubts, uncertainties, or conflicting evidence, which surround the various hypotheses, seems to us ill advised in an elementary text-book.

Although structural chemistry in a certain sense is independent of the valence hypothesis, still this hypothesis was one of the earliest and most natural inductions resulting from the study of the constitution of chemical compounds, and is so interwoven with the present theories, that any attempt to exclude it rigorously from a discussion of the subject merely adds an unnecessary complication. We confess that we do not think the ordinary student will read with much interest the pages devoted to structural formulae, or 'proofs' of their correctness, if he chances to see beforehand the opening sentence of the retrospect which follows (p. 232).

"A study of the preceding chapters on constitution will show that no absolute meaning is to be attached to the word. Constitutional formulas are those which suggest certain reactions, and recall analogies. The formula $CH_3 - OH$ does not mean that hydroxyl (OH) is necessarily present in the compound, or that CH_3 is present, but that the different parts of the compound bear such relations to each other that when the compound is decomposed, it acts as if the parts were united as the formula indicates. The formula suggests possibilities; it may not represent realities."

If the author be correct, and "it cannot be denied that we are now in a period of chemistry which may fairly be called one of *formula worship*" (p. 100), it is very certain that formula worship has been of vastly greater service to chemistry than agnosticism is ever likely to be.

We fail to see that any advantage is gained by the introduction of new conventional signs in place of those already in common use, to represent the linkage of the carbon atoms in the olefinet and acetylen series (pp. 202, 206): nor can we understand why the double linkage of the nitrogen atoms, which the author apparently accepts, since he uses the old sign (=) in his formulae for the azo- and the diazo-compounds (p. 222), stands upon any more trustworthy experimental basis. Furthermore, we cannot help expressing our surprise that the author should have ventured the statement, "Of the substitution products of benzene, which contain three substituting groups, more than three varieties have been observed" (p. 208), which seems a bit of rashness hardly consistent with the caution elsewhere displayed.

THE CORNELL MATHEMATICAL LIBRARY.

Cornell university library. Special lists, No. 1. Mathematics. Ithaca, N.Y., 1883. 92 p. 8°.

This classified list of works, with index, includes some twenty-five hundred titles relating to mathematics, and such allied subjects as astronomy, engineering, and physics. These books form what is known, from the name of the donor, as the 'Kelly mathematical collection.'

An examination of the list shows that it consists of books actually purchased within the past few years, with good judgment, and a conscientious endeavor to cover, so far as practicable, the immense field of mathematical research, past and present, as evenly as possible.

It comprises, besides many rare and valuable works not readily accessible to American students, the collected works of the great masters of analysis, and the more important mathematical journals.

The mathematical capabilities of American youth are quite equal to those of Germany or England; but the facilities offered them by our universities for the study of this grandest of sciences are in general far behind those found abroad. When the professors and teachers of mathematics in this country shall themselves become lifelong cultivators of mathematical pursuits, and shall have the same average proficiency as those abroad, there will be no difficulty in accomplishing results in the mathematical training of college students fully equal to any attained elsewhere. But such professors and such students cannot be without libraries such as this is the beginning of. We can but express our deep satisfaction with this good work in the interest of sound learning.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Kummer's surface. — Professor Cayley, in a brief note 'on the sixteen-nodal quartic surface,' remarks, that Riemann's theory of the bitangents of a plane quartic leads at once to a very simple form of the equation of the sixteen-nodal quartic surface; viz., if ξ, η, ζ, denote linear functions of the co-ordinates (x, y, z, w), such that identically

$$x + y + z + \xi + \eta + \zeta = 0,$$
$$ax + by + cz + f\xi + g\eta + h\zeta = 0$$

(where $af = bg = ch = 1$), then the quartic surface,

$$\sqrt{x\xi} + \sqrt{y\eta} + \sqrt{z\zeta} = 0,$$

is a sixteen-nodal surface. Prof. Cayley has previously given the equation of this surface under the form

$$\sqrt{x(X - w)} + \sqrt{y(Y - w)} + \sqrt{z(Z - w)} = 0,$$

where $X = a(\gamma'\gamma''y - \beta'\beta''z)$, etc., and $a + \beta + \gamma = 0$, etc.; the other relations being obtained by cyclical interchange of the letters, and by advancing the accents. The object of the present paper is the direct identification of these two forms of the equation of the surface. — (*Journ. reine ang. math.*, xciv.) T. C. [541

Elliptic functions. — M. Hermite has given a simple and direct demonstration of an interesting relation discovered by Prof. Cayley. The relation is as follows: if u, v, r, s, are four quantities connected by the relation $u + v + r + s = 0$, then we have —

$$-k'^2 \,\text{sn}\, u \,\text{sn}\, v \,\text{sn}\, r \,\text{sn} s + \text{cn}\, u \,\text{cn}\, v \,\text{cn}\, r \,\text{cn}\, s - \frac{1}{k^2}\text{dn}\, u \,\text{dn}\, v \,\text{dn}\, r \,\text{dn}\, s = -\frac{k'^2}{k^2}.$$

This remarkable relation is shown by M. Hermite to be easily derived by means of certain formulas which he has long used in his course in the Sorbonne. The formulas are those which give the decomposition into simple factors of the three quantities $\text{sn}\, x \,\text{sn}\,(x + a)$, $\text{cn}\, x \,\text{cn}\,(x + a)$, $\text{dn}\, x \,\text{dn}\,(x + a)$. The decomposition of the first of these products is a known fundamental relation between Jacobi's Z-functions: the decomposition of the other two products is given by M. Hermite; and by aid of them Prof. Cayley's formula is proved. — (*Acta math.*, i.) T. C. [542

ENGINEERING.

The two-cylinder compound engine. — Professor S. W. Robinson furnishes *Van Nostrand's magazine* a paper on the working of steam in this engine in its various forms, and traces the method of distribution in the two cylinders and the effect of such methods on the theoretical efficiency. He gives the general method of representing the action of steam graphically, and shows how diagrams made from the two cylinders are combined. The effect of the receiver is exhibited, and the result of the introduction of various conditions, as clearance, etc. — (*Van Nostrand's mag.*, Oct.) R. H. T. [543

Spherical steam-engines. — Messrs. Heenan & Froude of Manchester, G.B., recently exhibited at the Engineering and metal trades exhibition, London, their 'Tower' spherical engine, driving an Edison dynamo. The steam-cylinder is a sphere having two cylindrical projections cast upon it. Each of these carries a shaft, only one of which transmits power from the engine, the other having merely to guide the hinged piston nearest it. The pistons divide the interior of the sphere into four portions, which at times are four equal quadrants of the sphere, but which are capable of variation of volume with change of piston position; and, this being effected by the action of the steam which is let into the several spaces at proper times by the action of the rotating valves which are set in the cylindrical projections, the shafts are turned, and power is produced and transmitted to the mechanism of transmission.

The engine worked silently and well, and indicated 18-horse power at 600 revolutions per minute, with steam at 80 pounds ($6\frac{1}{3}$ atmos.). Its diameter was but 7 inches (17.8 centimetres). — (*London engineer*, July.) R. H. T. [544

Steel castings. — Mr. W. Parker has collected facts bearing upon the value of steel castings in marine-engine construction. He observes that forged iron shafts and other heavy parts are very unsafe, and that mild steel is taking the place of wrought iron for all such uses. About a hundred and twenty steel ships are in progress in Great Britain, constructed of low steel. The testimony of steel-makers and tests of the material show that steel castings can be made of homogeneous character and thoroughly reliable. Jessop & Co. use crucible steel for this purpose, and think that good castings can only be obtained with certainty by the crucible process. Spencer & Sons use both crucibles and the open-hearth process, and get equally good results from both. The Steel company of Scotland use the Siemens furnace and process, and adopt the silicide of manganese as a flux to insure soundness. The internal stresses due to variation in rate of cooling are avoided either by very slow cooling or by annealing. Pourcel of Terre Noire, France, tempers in oil, with, as is claimed, very great advantage. The tenacity is thus increased sometimes thirty per cent, and the elongation at rupture remains unreduced, while the grain of the steel is greatly improved. Sir Joseph Whitworth compresses his ingots of steel, while solidifying, by applying the pressure of a large hydraulic press. Messrs. Vickers & Co. make many large crank-shafts for steamships, adopting a mild steel of a tenacity of about fifty-five thousand pounds per square inch. The castings are improved by hammering or rolling, thirty per cent. — (*Scient. Amer.*, Oct. 20.) R. H. T. [545

CHEMISTRY.

(General, physical, and inorganic.)

Bleaching. — 'Oxygenated water,' a common name for peroxide of hydrogen, has within the last few years attracted a good deal of attention as a bleaching and purifying agent, and has been successfully employed as a substitute for chlorine. It is now stated that Mr. P. Ebell of Pfungstadt, near Darmstadt, has succeeded in preparing economically a product, pure, stable, and of constant strength, capable of being easily transported for long distances, and kept for years without losing its bleaching-properties. Among other applications of this product, that of the decoloration of animal fibres is the most important, as it does not contain some of the disadvantages of other bleaching-agents. For wool or silk, it is advisable, before bleaching, to cleanse the materials thoroughly, so as to eliminate all the greasy substances and impurities. For this purpose, Mr. Ebell recommends a bath in a solution of five parts carbonate of ammonia to one hundred of water, this bath being followed by a soaping, and thorough washing with water. The bleaching itself is performed either by immersing the materials in the solution of oxygenated water, and leaving them there at a temperature of from 20° to 30° C., until the decoloration is complete, or the materials are impregnated, when they are wrung out and exposed in a room heated to about 20° C.: they are then left to dry. — (*Engineer*, July 20.) [546

Molecular volume of liquids. — In the determination of the molecular volume of liquids, R. Schiff proposes to make the observations at the boiling-point of the liquid and in a special form of apparatus. The latter consists of a small flask capable of holding about one hundred grams of mercury: it is drawn out to a narrow neck which is graduated to ten divisions, each of which corresponds to 0.01 of a cubic centimetre; and each of these divisions is divided into five parts, making each of the final divisions equal to 0.05 of a cubic centimetre. The volume is accurately determined by weighing the flask filled with mercury to the zero-mark. To determine the specific gravity of any liquid at its boiling-point, the flask is filled with the liquid, placed within a jacket-tube which contains a little of the same liquid, and the latter boiled until the liquid in the flask is heated to its boiling-point. By means of a capillary tube the liquid is withdrawn from the flask until it stands at the zero-mark, and the flask is corked, cleaned, allowed to cool, and weighed. The specific gravity of the liquid is referred to water at 4° C., and it may be calculated by means of the formula —

$$D^t{}_4 = \frac{P}{V_t\left(1 + K(t - 4)\right)},$$

in which P = the corrected weight of the liquid in the flask, V_t = the apparent volume which the liquid occupies at t°.

By this method the molecular volume of many of the paraffine and aromatic hydrocarbons, their halogen substitution products, alcohols, etc., were determined, and results were obtained which agreed closely with those of other experimenters. — (*Ann. chem.*, 220, 71.) C. F. M. [547

AGRICULTURE.

Aves guano. — A new phosphatic material under this name has lately been imported into Germany from the Aves Islands, in the Caribbean Sea, near the coast of Venezuela. Analyses of it by Märcker and by Heiden show it to contain about seventy-two per cent of calcium phosphate, four to nine per cent of calcium carbonate, seven per cent of organic matter, and twenty-five hundredths of one per cent of nitrogen. The material consists of a fine powder, with more or less fragments up to the size of a pea or larger. Among the coarser portions, shells and coral fragments are often found. The extent of the deposit is said to be great. — (*Biedermann's centr.-blatt.*, xii. 582.) H. P. A. [548

Comparison of nitrogenous fertilizers.—Märcker reports the results of pot-experiments by Albert on the relative value of various nitrogenous fertilizers for oats. Leather, either unprepared or fermented, gave as good as no increase of crop. The others ranged in the following order, the best being placed first: horn-meal, nitrate of soda, fermented dried blood, sulphate of ammonia, fermented steamed bone, steamed bone, dried blood. The horn-meal is prepared by treating horn-refuse with superheated steam. In previous experiments it produced almost as good an effect as nitrate of soda. It is to be observed, that several of the materials used contained other fertilizing ingredients than nitrogen, of whose possible effect no account seems to have been taken. An experiment in the following year with the pots manured with leather showed no noticeable effect from the latter. — (*Biedermann's centr.-blatt.*, xii. 584.) H. P. A. [549

Effect of fertilizers on composition of oats — In the experiments reported in the preceding abstract the composition of the oats produced by the aid of the various fertilizers was determined. Those manured with leather and those without nitrogen contained 8.7 % to 10.7 % of proteine; those manured with nitrate of soda and sulphate of ammonia, 11.2 % and 11.1 %; those manured with the blood or bone manures, 11.6 % to 13.6 %. The proportion of crude fibre and ash was greatest in those manured with leather and those without nitrogen: the others showed only slight differences. The nitrogenous manures delayed the ripening of the grain in some cases. Märcker divides them into three groups: 1°, those which allow the grain to ripen at the normal time, their nitrogen being assimilated during the early stages of growth (nitrate of soda, sulphate of ammonia); 2°, those which delayed the ripening somewhat (steamed bone, and the same fermented); 3°, those which delayed the ripening considerably, and rendered it irregular (horn-meal, dried blood). The last decompose slowly in the soil, and furnish a continuous supply of nitrogen until late in the autumn. — (*Biedermann's centr.-blatt.*, xii. 587.) H. P. A. [550

Nutritive value of amido-compounds.—Weiske has already shown that the asparagine which is found in various fodders, along with other amides and amido-compounds, can partially take the place of proteine in nutrition. Zuntz has repeated his observations on asparagine and other amides, with the same result. — (*Biedermann's centr.-blatt.*, xii. 602.) H. P. A. [551

Sunflower cake as fodder. — This material has been tested as fodder for milch-cows by Schrodt and von Peter with very favorable results. Slightly more milk was produced by its aid than by that of an equivalent quantity of palm-nut meal; and the proportion of fat in the milk was slightly increased, as has sometimes been the case in feeding palm-nut meal. No injurious effects on the health of the animals were noticed. — (*Biedermann's centr.-blatt.*, xii. 609.) H. P. A. [552

GEOLOGY.

Lithology.

Lithology of the District of Columbia. — According to Mr. G. P. Merrill, the prevailing rock of this district is an extremely variable hornblendic, chloritic, or micaceous schist, sometimes somewhat gneissoid. This rock is used for building-purposes in its finer varieties, which are composed of quartz and biotite, with a silvery white mica, magnetite, apatite, etc. Besides the quartz and biotite, the coarser varieties frequently contain plagioclase, hornblende, chlorite, apatite, epidote, pyrite, magnetite, garnet, and rutile. The biotite is frequently more or less altered to chlorite, and contains apatite, magnetite, and sometimes infiltrated calcite. — (*Proc. U. S. nat. mus.*, vi. 159.) M. E. W. [553

The bismuth deposits of Australia. — These deposits are found in irregular quartz veins or 'reefs' in gray granite, and near its junction with the surrounding porphyritic and schistose rocks. The veins are composed of irregular segregations of quartz, holding bismuth, both native and as a sulphide, gold, molybdenite, smoky quartz crystals, etc. These veins occur only in circumscribed patches in the granite, which has here been decomposed to a soft, friable rock, the mica and felspar being much altered. The native bismuth occurs in irregular bunches and nests throughout the quartz, or in fissures traversing the veins. These bunches vary in weight from a half-pound to fifty pounds; and the metal is particularly found associated with and incasing the crystals of smoky quartz. Sometimes it is in needles in the quartz. The walls of the segregations are charged with from thirty to fifty per cent of oxide of bismuth for a distance from the vein of from eight inches to two feet.

Mr. Robertson, from whose paper the above account is condensed, states that the entire sale of bismuth has for years been monopolized by a few London brokers, "known as the 'Bismuth ring,' — a close and conservative institution formed for the purpose of controlling the supply and price of bismuth." The present consumption of the metal is about seventy tons yearly; and it is stated that these deposits could easily produce that at a small expense. In 1882 the market-price of bismuth was 6s. 8d. per pound in London. — (*Trans. geol. soc. Glasgow*, vii. 127.) M. E. W. [554

MINERALOGY.

Halite. — B. Wittjen and H. Precht have endeavored to find the cause of the blue color in some varieties of halite, and have arrived at the conclusion that it is dependent upon some optical phenomena, possibly connected with the presence of minute gas inclusions. — (*Berl. berichte*, xvi. 1454.) S. L. P. [555

Rubellan. — This micaceous mineral has been investigated by M. U. Hollrung, and shown to be very various in its properties. It occurs mostly as a decomposition product of magnesian micas. It is by no means homogeneous, and cannot be classed as a distinct mineral. By means of the microscope it could be seen that crystals of the ordinary biotite form were composed of lamellae of different degrees of decomposition, showing all stages from pure mica to wholly decomposed material. — (*Min. petr. mitth.*, v. 304.) S. L. P. [556

Parallel growth of zinc blende and tetrahedrite. — Specimens from Kapnik, Transylvania, have been studied by F. Becke. The minute crystals of tetrahedrite are deposited only upon the dull faces of the blende crystals, and are of a later growth. They have been deposited according to the following law: the principal axes of the two minerals are parallel, and the first or principal tetrahedron of tetrahedrite is parallel to the second tetrahedron of blende. The development of the tetrahedrite crystals is dependent upon their location on the blende, being most symmetrical if deposited on a dodecahedron face, and flattened if on a cubic face. A parallel growth of these two minerals has been previously noted, but with the first tetrahedron of tetrahedrite parallel to the first tetrahedron of blende. — (*Min. petr. mitth.*, v. 331.) S. L. P. [557

Iolite (cordierite). — A. von Lasaulx has described twin crystals occurring in a cordierite gneiss from Laacher See. Twins of this species are of unusual occurrence, and have been observed with the prism ∞ P for composition face. The author finds, in addition to twins according to the old law, compound twins, part of the individuals being united according to the old law, and part according to a new law with $\infty \breve{P} 3$ for composition face. Twins united wholly according to the new law were not observed. — (*Zeitschr. kryst.*, viii. 76.) S. L. P. [558

GEOGRAPHY.

(Arctic.)

Arctic land. — F. Schmidt discusses the claims of different persons, and especially Wrangell, to the discovery of land north of eastern Siberia. Discovery is hardly the proper word to apply to the record of reports by the aborigines of that region. In fact, as Professor Schmidt admits, Wrangell had his doubts as to the accuracy of the report; and his opinion was expressed, sometimes with more, sometimes with less, confidence, at different times. The first civilized man to actually see what is now called Wrangell Island was Kellett, who called it Plover Island, and made a sketch of it from a long distance away, of which I have a copy, and which is stated to be characteristic by Capt. Hooper. The high land, with extensive peaks, described by Kellett, like the Pelly Mountains of the arctic coast, described by Dease and Simpson, was simply one of those peculiar atmospheric effects which occasionally deceive the most experienced arctic travellers. The conclusion is, that no report of new arctic land is worth any thing until it has at least been very closely approached. — (*Isvestia imp. geogr. soc.*, May.) W. H. D. [559

Settlements on the Siberian coast. — Karzin gives a most valuable list of the settlements, summer fishing-stations, camps of ivory-hunters, and other places, where human beings are to be found at any season of the year on the coast of north-eastern Siberia. The chronicles of the Jeannette expedition might have been less gloomy, had the commander possessed himself of some such directory before proceeding on that unlucky voyage. — (*Isvestia imp. geogr. soc.*, May.) W. H. D. [560

(*Africa.*)

Sierra Leone. — According to recent consular reports, the population of this colony comprises sixty thousand five hundred souls, nearly all blacks, who speak among them more than sixty different dialects. Freetown, the capital, has a population of twenty-two thousand, chiefly of the Aku, Ebo, Timen, Susu, Maulang, Sherbru, and Krumen tribes. The Aku and Ebo people are extremely keen traders: the three following tribes furnish middlemen, who intervene between the caravan merchants and the purchasers. The last mentioned are freighters and boatmen, employed largely in loading and discharging vessels. The trade amounts to about three million dollars annually, less than half of which are exports. The soil is poor and not arable; farming is hardly practicable; and the real importance of the colony lies in its geographical position, and easy communication with the rich interior region. Taxes and customs-duties are very high, and have injured trade by driving it elsewhere. The exports are kola, palm and peanuts, palm-oil, gum-copal, rubber, ginger, and hides. — (*Bull. soc. Belg. géogr.*, ii. 1883.) W. H. D. [561

Portuguese Guinea. — Barros contributes a memoir on Portuguese Guinea, with notes on the customs and manners of the natives and on their language, especially of the Mandingo, Biafada, and Balanta tribes, containing little absolutely new except some songs. The article forms an interesting summary of facts. — (*Bol. soc. geog. Lisboa*, no. 12, 1882.) W. H. D. [562

BOTANY.

Cryptogams.

The oospores of the grape-mould. — Prillieux states that he has received from M. Fréchou of Nérac germinating oospores of Peronospora viticola. The germinating oospores produce at once a mycelial tube similar to that known in other species of Peronospora, in which the germination of the oospores has been seen. This is an important step in our knowledge of the grape-mildew, since, inasmuch as the conidia produce zoospores, it had been supposed by some that the oospores would also produce zoospores, as is the case in the related genus Cystopus. — (*Bull. soc. botan.*) W. G. F. [563

Swedish Algae. — Dr. C. Lagerheim describes a number of species new to Sweden, including several genera and species new to science. The species are from fresh water, as well as marine, and are illustrated by a plate. Of the genera treated most in detail may be mentioned Merismopedium. — (*Öfvers. svensk. akad.*) W. G. F. [564

Monograph of Ulvaceae. — The sixth part of Agardh's *Till algernes systematik* is devoted to the Ulvaceae. The author includes here the genera Bangia and Porphyra, as well as the green species generally placed in this order. The subject is elaborately prepared, and is illustrated by four colored plates giving the microscopic structure. Ulva and Enteromorpha are kept distinct, and E. erecta is credited to New York on the authority of J. Hooper. Monostroma pulchrum the writer suspects to be a form of M. lactuca, a boreal species of both hemispheres. — (*Acta univ. Lund.*, xix.) W. G. F. [565

Phanerogams.

Spines of Aurantiaceae. — Dr. Urban describes and figures specimens which show that the spines situated just above the leaf-axis of a number of members of this family, and hitherto considered as metamorphosed axillary branches, are in reality formed by the transformation of one or two of the lowest leaves belonging to the primary axillary shoot. — (*Ber. der deutschen bot. gesellsch.*, June 27.) W. T. [566

Orchis mascula. — Mr. Malair believes that the visits of bees to this species are for propolis, which is yielded by the papillae of the nectary. Flies also visit the flowers, which are described at length, but not very clearly nor accurately. — (*Science gossip*, March, April.) W. T. [567

Sterility of the Ficaria. — Mr. Neve notices that in England the plant seldom seeds, although its flowers appear well formed, and bees visit them. — (*Science gossip*, June.) W. T. [568

Pollination of willow. — Mr. Hamson states, that while amentiferous plants, dependent entirely upon the wind for fertilization. have pendulous catkins, "in the willow the catkins are upright and elastic. The bumble-bee is a heavy insect, and it almost invariably mounts to the summit of the catkin, which is borne down by its weight. On the bee taking flight, the catkin springs suddenly to its original position, and thus shakes out the pollen in the male, and further distributes that which may have lodged in the scales of the female catkin." Bees were noticed to confine their visits almost exclusively to the staminate plants. — (*Science gossip*, July.) W. T. [569

ZOÖLOGY.

Protozoa.

Division of the nucleus in protozoa. — It is known that in many protozoa the number of nuclei increases with the growth of the animal; but whether the additional nuclei arise by free new formation, or by division of older nuclei, was uncertain, although Zeller had shown that the multiplication in Opalina was due to division. Gruber, in a valuable article, now shows that in Actinospaerium and Amoeba division of the nuclei occurs, having obtained examples after very long search. In the former the young nuclei are small, and have a single large nucleolus with a clear space around it. As the nucleus enlarges, the clear margin disappears, and the nucleolus breaks up into smaller granules (nucleoli). In one specimen various stages of division were found. Their natural succession is probably as follows: the nucleoli arrange themselves in two parallel rows across the nucleus; they then unite so as to form a homogeneous band out of each row; the rest of the nuclear substance accumulates between the two bands, which then move asunder, and meanwhile threads appear running from band to band; a line of division (partition-wall?) appears between the bands. In Amoeba proteus the nucleus contains a peripheral layer of granules, and a large central mass to be regarded as the nucleolus. One specimen was found with nuclei in various stages of division. It appears that the nucleolus separates into two parts, between which, across the equator of the nucleus, appears a partition. Similar processes were observed in another Amoeba (sp.?). In these cases we have a form of nuclear division somewhat different from any hitherto observed; in that the nucleolus divides first, and the partition between is formed without the participation of the nuclear membrane.

Bütschli has asserted that in Amoeba proteus (princeps B.) the nuclei are either small and numerous, or large and few. Gruber has found them always of about the same size, and very variable in number and relative proportion to the bulk of the individual. — (*Zeitschr. wiss. zool.*, xxxviii. 372.) C. S. M. [570

Coelenterates.

The nervous system of the Siphonophores. — According to Korotneff, who has studied the minute anatomy and histology of the Siphonophores, the Diphyidae are the least modified, and present the most primitive or ancestral structure. In them the ectoderm is a simple muscle-epithelium with well-developed muscle-fibrillae, which lie upon *muscle-septa*, or outgrowths from the supporting layer.

A more highly differentiated organization is found in the Apolemiadae. The epithelial cells are nearly separated from the muscle-fibrillae, to which they are united only by fine protoplasmic threads. Between the muscle-septa the epithelial cells are folded over to form an open furrow, which is floored with cells a little larger than those over the general surface of the body.

In the Agalmidae the cells in this furrow are entirely covered up by the ordinary surface-epithelium. They are very large, are united by processes to the muscles, and they constitute a true central nervous system formed by involution of the ectoderm. The muscle-fibres of the Agalmidae are entirely separated from the epithelial cells, and the latter are flattened. Korotneff has traced the origin of the nervous system in the embryo. In a Forskalia larva there is no trace of nerve-cells; and the epithelio-muscular layer, the muscle-septa, and the endoderm are like the corresponding structures of Diphyes.

As the animal grows, these ectoderm-cells, which lie between the muscle-septa, grow larger, sink down, and become covered up by the ordinary surface ectoderm-cells. They then throw off processes to the muscle-fibres, and thus become converted into the nervous system. The nerve-cells are therefore, so far as their origin is concerned, epithelio-muscular cells, and they so far lend support to Kleinenberg's neuro-muscle theory.

Korotneff describes sensory cells in the region of the nervous system of the Agalmidae, and also in the air-bladder. These sensory cells are muscle-cells which still retain their primitive position on the surface; and they are furnished with sensory hairs, and are joined by processes to the muscle-fibrillae.

In the Physophora the ectoderm has been specialized in two ways. On the stem the cells have the morphological characteristics of nerve-cells and the position and arrangement which characterize muscle-cells: they are neuro-epithelio-muscular cells. There are also many sensory cells arranged in longitudinal rows among the ordinary cells; but there is no infolded nervous system upon the stem, as there is in the Agalmidae. This is to be found, however, upon the air-bladder, which is thickly covered with nerve-cells. On the upper surface of the bladder these are directly united to the surface-epithelium, while upon the lower surface they are directly united to the muscles. He says that there are physiological reasons (which are not stated) for believing that the upper nerve-cells are sensory, and those on the lower surface motor.

He speaks very briefly of the diffused nervous system of Porpita; and his observations apparently agree with those recently published more at length (see SCIENCE, ii. 396) by Conn and Beyer. — (*Zool. anz.*, 148.) W. K. B. [571

Worms.

Systematic papers on worms. — Dr. R. v. Drasche has taken advantage of the preservation of all Diesing's and many of Molin's original specimens of nematods in the Vienna museum to draw up fresh and more accurate diagnoses of the species described by these authors, and also to give a good many new figures. This labor is calculated to avoid much confusion which might otherwise arise from the very imperfect character of the original descriptions. — (*Verh. zool-bot. ges. Wien*, xxxii. 117.)

The same author also describes some new ascarids collected in Brazil by Natterer, and adds some notes on Ascaris ovis and A. rigida. — (*Idem*, 139.)

G. M. R. Levinsen has published the first part of a valuable revision of northern Annulata, Gephyrea, Chaetognathi, and Balanoglossi. He attempts chiefly to describe the species, elucidate their history in scientific writings, and their geographical distribution. The essay contains full synoptic tables. The work was undertaken at the request of Prof. Steenstrup and Dr. Lütken. — (*Vidensk. meddel. naturh. foren. Kjöbenhavn*, 1882, 160.) C. S. M. [572

Pentastomum from an Alligator lucius. — J. Chatin has found Pentastomum, probably P. oxycephalum, in the liver of a caiman. This is a new locality for the parasite. He gives an excessively prolix general account of the anatomy of the animal, but contributes little that is new. The booklets around the mouth have a stalk, and three movable claws thereon, — two at the sides near the end, the third terminal. The author denies the cellular character of the epidermis: it is 'formed merely by a mass of protoplasm in which are scattered numerous nuclei.' (It can hardly be questioned that this is a mistake due to superficial observation. The author gravely adds his doubts as to the cellular constitution of the epidermis in arthropods generally. In this he is singularly unfortunate; as there is hardly any fact in insect histology more easily verified, even by inexperienced students, than the existence of epidermal — so-called hypodermal — cells. The error of describing an epithelium as a sheet of protoplasm with scattered nuclei has been committed over and over again by persons not trained in histology.) The description of the course of the nerves rectifies previous accounts. — (*Ann. sc. nat. zoöl.*, xiv. art. 2.) C. S. M. [573

Crustaceans.

Isopoda of the Blake dredginga. — In a report on the Isopoda dredged on the east coast of the United States in 1880, by the U. S. coast-survey steamer Blake, under the direction of Alexander Agassiz, Oscar Harger says that the collection, although small, is remarkable for the large proportion of interesting forms; since nearly all the species are either new, or not hitherto known upon our coast, or known only from single specimens. Nine species, all belonging to Cirolanidae and Aegidae, are enumerated, and most of them fully described and figured on four excellent photo-lithographic plates from the author's drawings. — (*Bull. mus. comp. zoöl.*, xi., no. 4, Sept., 1883.) S. I. S. [574

Development of Panopeus. — E. A. Birge describes and figures the post-embryonal and some of the later embryonal stages of Panopeus Sayi and the second zoea stage of P. depressus. He describes four distinct zoea stages after the casting of the embryonic cuticle (or 'larval skin,' as Prof. Birge calls it) and a 'first megalops stage,' and discusses the metamorphoses undergone by the body and appendages in the change from each stage to the next. After describing the 'first megalops stage,' Prof. Birge says, "Subsequent changes in the megalops affect the proportions of the carapax, which becomes broader proportionally, and that of the abdomen, which becomes smaller, and is permanently flexed under the sternum. The appendages undergo many changes, gradually approximating them to the adult form. The last stage is reached after several — at least four — moultings." Unfortunately none of these remarkable later megalops stages are described or figured, as they certainly deserve to be if actually observed. During several seasons' observations the writer has found no evidence of more than one megalops stage in this or allied species; and, with the exception of Bate's doubtful observations on Carcinus, there are apparently no well authenticated cases of several megalops stages in any species of Brachyura. The numerous figures illustrating the paper are rude and inaccurate. — (*Stud. biol. lab. Johns Hopk. univ.*, ii., no. 4, July, 1883.) S. I. S. [575

Insects.

Sucking-apparatus in butterflies. — P. Kirbach describes the structure of the maxillae and pharynx in the Lepidoptera precisely as described by Burgess in the *American naturalist* for May, 1880, and more at length in a memoir on the anatomy of the milk-weed butterfly in the *Anniv. memoirs Bost. soc. nat. hist.*, 1881. Kirbach makes no reference to either of these papers, though both were recorded in the very journal containing his article, as well as in Carus's *Zool. jahresbericht* by Bertkau, in the *Arch. f. naturgesch.*, and in the *Zoölogical record*. However, it is satisfactory to have observations independently confirmed; and Kirbach gives almost a verbal and pictorial repetition of the above-quoted papers. Thus the suspensory muscles of the pharynx receive the identical names given them by Burgess. Kirbach believes the proboscis is extended by muscular contraction, and rolled up by elasticity, but gives no proof of his view. This is the opposite of what the muscular arrangement *seemed* to Burgess to indicate; although he added that "it is more probable we fail to see, or to correctly interpret, some proper muscular mechanism for both movements of the proboscis." Unfortunately, Kirbach does not help us here.

Kirbach describes, for the first time, the syringe-like mechanism of the salivary duct, by which saliva is injected into the proboscis. This arrangement was overlooked by Burgess. — (*Zool. anz.*, vi. 553.) E. B. [576

Wheat-atem maggot or bulb-worm. — The larva of Meromyza americana Fitch has been very destructive this year to wheat and rye in Fulton county, Ill. Important additions to the published observations of Fitch, Riley, and Lintner, have been made by S. A. Forbes, who gives descriptions and figures of all stages of this insect. The egg is now figured for the first time, and a winter brood has been observed. — (*Prairie farmer*, Aug. 4.) J. H. C. [577

VERTEBRATES.

Histology of the nervous centres. — C. Golgi has investigated the morphology of ganglion-cells. His conclusions are in some respects very different from those of previous investigators, and, if confirmed, will mark an important advance in our knowledge of the subject. On this account we give a longer abstract than usual for special papers.

The origin of the nervous fibres depends on certain constant laws, uniform for the different centres, despite certain secondary differences in the morphology and distribution of the histological elements. The ganglion-cells may in general be distinguished from the other cells by their form, the appearance of their nuclei, and the mode of origin of their prolongations; but they are especially characterized by the presence of the *single* nervous (Deiter's) process, which *alone* enters into connection with the nerve-fibres to make part of, or constitute them. The protoplasmatic processes have nothing to do with the origin of the nerve-fibres, directly or indirectly: they are in relation with the connective-tissue corpuscles (exactly how is not shown, so this may be questioned). As each cell has only one Deiter's process, it follows that they are all really unipolar. The sensory and motor cells cannot be distinguished definitely by their form or size from one another; but, as regards Deiter's process, two forms are distinguished, — the first is supposed to go with the motor cells, the second with the sensory. The established view that the process is continued without branching into the axis-cylinder is discarded; for Golgi maintains that it gives off a more or less considerable number of filaments on its way. In the first form, the process, although giving off filaments, still maintains its individuality, and can be followed to the points where it enters the medullary sheath as the axis-cylinder. Corresponding nerve-fibres are found, which preserve their individuality, notwithstanding the filaments they give off from the axis-cylinder, which can be followed to the ganglion-cells. The structures are supposed to belong to the sensory system. In the motor system the individuality of the process or of the fibre is lost in the gray substance, completely breaking up into filaments which enter into the formation of a diffuse network. It would appear, then, that the motor process breaks up into filaments, forming a network, from which spring the other filaments, which unite to form the motor axis-cylinder. The network really receives filaments also from the sensory process and fibres; so that it may be regarded as a fundamental nervous plexus, both sensory and motor, by means of which each fibre communicates, not with a single cell, but with large groups. The tendency is towards extended, not restricted, communications; and there is no anatomical basis for the assumption of the isolated transmission of peripheral nervous impulses to hypothetical limited cellular individualities. This investigation, therefore, lends no support to the theory of cerebral localization. Deiter's process is characterized from its origin by its greater homogeneousness, its hyaline aspect and smooth surface, while the protoplasmatic processes are granular.

Golgi has also studied the histology of the *cortex cerebri*, especially to compare the anterior with the occipital convolutions. Meynert's plates, and division of the cortex into five layers, he thinks, do not agree with the reality. Golgi distinguishes three forms of ganglion-cells, — pyramidal, fusiform, and globular (or polygonal with rounded angles). He distinguishes three layers of about equal thickness. The superficial layer is formed almost exclusively by rather small pyramidal cells; the middle layer has, for the most part, larger pyramidal cells; while in the deep layer the fusiform cells prevail, and the globular cells, which occur throughout the cortex, are here most abundant. The largest pyramidal cells extend through the whole thickness of the cortex. Such is the organization of the *gyrus centralis anterior* (*frontalis ascendens*). The organization of the superior occipital convolution is similar, except that the deep layer contains the globular cells almost exclusively. There are no anatomical features to indicate that the anterior convolutions are motor, the occipital sensory, as Hitzig and others have maintained. "The specific functions of the different cerebral zones do not depend on the organization of these zones themselves, but on the specific character of the peripheral organs which are connected with the fibres entering or leaving the zones in question." — (*Arch. ital. biol.* iii. 285.) C. S. M. [578

Birds.

Development of the heart. — Assaky maintains, 1°, that the heart arises in the chick as a double tube, as may be seen before the differentiation of the third protovertebra; 2°, the myocardium is constituted from the first by a network of anastomosing cells; the muscular fibres arise by endocellular generation; 3°, the muscle-cells are derived from amoeboid cells [i.e., are mesenchymal]. — (*Comptes rendus*, xcvii. 183.) C. S. M. [579

Plumages of the stone-chat. — Messrs. Butler, Fielding, and Reid seem finally to have solved the variations in plumage of this interesting bird. According to them, there are nine different stages easily recognizable. We note with satisfaction that the theory of hybridization seems to be done away with. — (*Ibis*, 1883, 331.) J. A. J. [580

Mammals.

The influence of quinine upon heat-dissipation and heat-production. — In a late article by Wood and Reichert (*Journ. of physiol.*, iii. 321), the authors make the statement that quinine increases both heat-production and heat-dissipation, though, on the average, the percentage of increase of heat-dissipation largely exceeds that of heat-production. A desire to test the accuracy of these results has led Arntz to make a similar series of experiments. To measure the relative amount of heat-dissipation from the skin, he made use of a porous wooden cap, lined with felt, which could be applied to any part of the body. The temperature within the space thus enclosed was registered by a delicate thermometer. Any increase in the loss of heat through the skin would be shown, therefore, by the thermometer. Experiments were made upon men and rabbits in a normal healthy condition, the general results of which show that no increase in heat-dissipation follows the injection of quinine. To explain the contradiction existing between his own and Wood's results, he supposes that the doses used by the latter were too large for the animal (dog) experimented upon; and the increase in heat-dissipation was probably owing to the animal's struggles and attempts to vomit. Two experiments that he made upon dogs, using the same dose as that given by Wood, tend to support this explanation. To determine the effect of quinine upon heat-production, spirometric observations were made upon normal rabbits, and rabbits suffering from septic fever, the amount of oxygen absorbed being taken as an indication of the oxidations going on in the body. In normal rabbits, quinine was found to have no effect upon the amount of oxygen consumed; while, in febrile animals, it caused a diminution in the oxygen-consumption. The author's conclusion, with regard to the anti-pyretic action of quinine, is, that it acts in the first place indirectly by destroying the organisms which give rise to the fever, and, in the second place, directly diminishes the oxidations in the tissues of the body. — (*Pflüger's archiv*, xxxi. 531.) W. H. H. [581.

Action of carbon dioxide and oxygen upon the mammalian heart. — The present paper by Klug forms an extension of some previous work of the same nature on the frog's heart. His experiments were made upon dogs anaesthetized by means of morphia, and made to breathe in an atmosphere containing different percentages of carbon dioxide or oxygen. With regard to the action of carbon dioxide he finds, in accordance with previous observers, that it acts as a stimulus to the vaso-motor and cardio-inhibitory centres of the medulla; but, in opposition to the statements of Traube and Landois, he asserts that it disables the intrinsic motor centres of the heart. He grounds this statement on the fact, that, after section of the vagi and the cervical cord, the heart soon ceases to beat, when the animal breathes in an atmosphere containing from twenty to forty per cent of carbon dioxide. Breathing in an atmosphere of oxygen stimulates both the inhibitory and accelerator centres of the medulla: and the author repeats for the mammal a statement made with reference to the frog; viz., that oxygen acts as a constant stimulus for the heart-contractions. Want of oxygen, like carbon dioxide, stimulates the inhibitory and vaso-motor centres, and first stimulates, then depresses, the accelerator centres. — (*Arch. anat. physiol.*, 1883, 134.) W. H. H. [582

Maturation and impregnation of the mammalian ovum. — G. Rein has investigated these phenomena in rabbits and guinea-pigs. He describes minutely his manner of obtaining the desired material. In rabbits the tuba can be cut open, and examined with a lens: in guinea-pigs it is better to collect the eggs by pressing out the excised tuba with a blunt instrument. They may be examined fresh in the fluid from the oviduct, and even kept so for some time, if the cover-glass is surrounded by a rim of oil, and the slide placed in a warm box. To preserve the eggs, fix with (.1%–1%) osmic acid, place them for two or three days in Müller's fluid, and mount in glycerine.

The so-called corona radiata consists of the cells (changed to the spindle form) of the discus proligerus. It is most marked in the rabbit immediately before the bursting of the Graafian follicle, i.e., nine to eleven hours after copulation; by which time one polar globule has generally been formed. The cells of the corona present features most unusual in epithelia: they are elongated, spindle or star shaped, with processes which branch often and anastomose with one another; they are probably forced apart by the liquor folliculi, which accumulates, especially during the last hours before the bursting of the follicle; after that event they resume their original form. As the ovum matures, the nucleus is distended, and assumes an eccentric position and oval form. The nucleolus is replaced now by a cluster of granules, which then scatter themselves through the yolk, become smaller and ultimately indistinguishable. The nucleus comes to lie close against the zona pellucida, and there is flattened out. The next change is the expulsion of the first polar globule, which appears to be formed out of the germ-vesicle. No karyokinetic figures were observed in connection with the process. Rein suggests that possibly the mammalian polar globules are not complete homologues of those of the lower animals. The maturation is further marked by the contraction of the yolk, first, at the point where the polar globule is ejected; second, general, so that the yolk recedes, as in other mammalia, from the zona pellucida. In three cases active protuberances on the yolk were observed (cf. Kupffer, ante, i. **1132**). In the mature ovum also appear yolk-grains larger and much darker than the other granules. In four cases a second nucleus was observed more in the centre of the egg, probably the egg-nucleus (or female pronucleus).

Impregnation takes place in the middle third of the tuba thirteen to seventeen hours after copulation. Two pronuclei (male and female) are seen in the ovum: they travel towards one another, meet eccentrically, make amoeboid movements, and sometimes are quite near the surface. The radiating lines could not be seen in most cases around the pronuclei. At the time of impregnation the cells of the corona have partly fallen off. Numerous spermatozoa crowd around the egg, several pass the zona; but probably only *one* enters the yolk. The pronuclei pass to the centre of the ovum, the amoeboid movements continue; one pronucleus becomes crescent-shaped, and embraces the other: the two then probably unite. — (*Arch. mikros. anat.*, xxii. 233.) C. S. M. [583

Duration of systole and diastole of heart-beat. — From a series of experiments made upon the dog, Howell and Ely have come to the conclusion that variations of arterial pressure from fifty millimetres to a hundred and sixty millimetres of mercury have no direct effect whatever upon the duration of either systole or diastole. The experiments were carried out upon hearts completely isolated from every other organ of the body, except the lungs, after the method devised by Prof. Martin. The contractions of the heart were registered by means of a Fick spring manometer connected with the cavity of the right ventricle, and the time relations of the beat were determined by comparing this curve with the simultaneous tracing of a tuning-fork vibrating fifty times a second. — (*Stud. biol. lab. Johns Hopk. univ.*, ii. 453.) W. H. H. [584

ANTHROPOLOGY.

Tattooing among civilized people. — Last December Dr. Robert Fletcher read a paper on tattooing among civilized people, which he is now publishing. The custom presents itself from two points of view, — the medico-legal and the anthropological. Compared with the elaborate tattooing of many savage tribes, the designs which sailors, soldiers, and, above all, criminals, have imprinted on their persons, are trivial or offensive in subject, or clumsy in execution. In 1869 Berchon made several reports to the French government on tattooing among sailors and criminals, and published a work entitled 'Histoire médicale du tatouage.' At the meeting in Algiers in 1881, of the French association for the advancement of science, Magitat exhibited a chart showing the geographical distribution of tattooing, according to methods, as follows: 1. By pricking; 2. By simple incision; 3. By ulceration or burning; 4. Hypodermic tattooing; 5. Mixed tattooing. Among the distinguished observers of this practice are Cesar Lombroso of Turin, and Dr. A. Lacassagne of Lyons. Lombroso publishes a chapter on tattooing in his 'L'uomo deliquente,' and Lacassagne is the author of a volume entitled 'Les tatouages, étude anthropologique et médico-légale.' He gives a table showing the parts of the body operated upon in 378 subjects, and also one containing the details of 1,333 tracings obtained from the battalion d'Afrique, as follows: —

Patriotic and religious emblems	91
Professional emblems	98
Inscriptions	111
Military emblems	149
Metaphorical emblems	260
Amorous and erotic emblems	280
Fantastic, historical, and miscellaneous,	344
	1,333

The reader will find this one of the most entertaining and instructive anthropological papers which have appeared in a long time. — (*Trans. anthrop. soc. Washington*, ii. 40.) J. W. P. [585

The Mexican pulque. — "One of the first objects to claim the attention of the conquerors of Mexico," says Carl Beni, "was the maguey-plant (Agave americana; Mexican, *ncutlli*). Its manifold uses and products, considered in relation to the inhabitants of that region and to their manner of living, render interesting the study of this vegetable, which is justly called *pianta delle meraviglie*." De Candolle thinks that the plant is of Mexican origin; but the place where it was discovered to furnish a beverage is uncertain, for traditions concerning it are intimately connected with the history of the ancient peoples who occupied the central plateaus of South America. According to the Mexican traditions, Ixquitecatl was the first to invent the method of drawing the sweet juice from the maguey, and Titlacahuan used pulque to intoxicate Quelzalcoatl and to induce him to go into exile. Another legend says, that in 1045 the juice of the plant was introduced as a drink among the royal family. Signor Beni has collected from various sources the references to the uses of this celebrated plant, and in 1876, while in Mexico, made some observations on its cultivation and uses. The following is the analysis of the sap and of the fermented liquor: —

	Sap.	Pulque.
Albuminous substances	25.40	12.57
Sugar	95.53	8.23
Salts	7.26	2.20
Absolute alcohol	0 00	36.80
Water, gas, and waste	871.81	940 20
	1000.00	1000.00

— (*Archiv. per l'antrop.*, xiii. 13.) J. W. P. [586

The use of mollusks. — Dr. A. T. de Rochebrune has written a second memoir upon mollusks among ancient and modern peoples, this time treating of shells in the sepulchres of Ecuador and New Granada. The mounds of the United States furnish some beautiful specimens of aboriginal art in shell, and our archeologists have not been slow in taking advantage of the interest clustering about these objects. The relative rarity of mollusks utilized by the ancient inhabitants of the Peruvian coast is noticed by M. Rochebrune. The farther north we go, the more pronounced this poverty becomes. Indeed, the following five species are all that the author has found from that region: —

1. Spondylus limbatus Sow, statuettes and necklaces.
2. Venus multicostata Sow, spangles, necklaces.
3. Patella olla Brod., bangles, quippus(?) beads.
4. Oliva splendidula Sow, bangles, pendants.
5. Fasciolaria salmo Wood, pieces for clothing.

Two or three of the objects are carved with some elaborateness of design. — (*Rev. d'ethnog.*, ii. 311.) J. W. P. [587

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Comparative paleontology of the Devonian formation. — Prof. H. S. Williams has recently been devoting his attention especially to this formation in western New York, and, in a preliminary report to the director, makes known some interesting facts as a result of his study of the materials collected by him during the past summer.

In the black shales, which in New York lie between beds containing Hamilton faunas below and those bearing Portage faunas above, he has found Lingulas indistinguishable from those of the Cleveland shales; also conodont teeth identical in form with those described from the same Cleveland beds, and Sporangites and Palaeoniscus scales. Species, therefore, regarded by Ohio geologists as characteristic of the Cleveland shales (Waverly), occur together in a similar black shale in New York, which there is known to underlie the upper Devonian. Professor Williams says, however, that, although the identity of the two faunas can scarcely be disputed, he is not so sure that it is an indication of synchronous deposition. The various black shales of Ohio are more nearly continuous there than in New York; and he says it is pretty clear that the intercalated sandy deposits are of a more eastern origin. At the horizon of upper Devonian the sands are purer and of lighter color as we go westward and south-westward; and in some of the quarries of western New York, sandstones very similar to the Ohio Waverly stone are met with. In these sands distinct quartz pebbles have been found, nearly as low as the point where the first member of the typical Chemung fauna is obtained, leading Professor Williams to suspect that true conglomerates may, in some geographical area, have been contemporaneous with the early Chemung fauna. He says the evidences are accumulating in support of the hypothesis that the lower conglomerates are the geographical representatives of deposits of much finer character farther north, in which the Chemung faunas appear. He meets the argument for a high geological position of the conglomerates (based on an assumed regular dip towards the south-west in this region) by the supposition that conglomerates must express nearness to shore, and that, running along a line from shore into deep water, it is safe to assume that for any given length of time the thickness of the deposit will diminish with the distance from the shore; and hence, if the general relation of shore to deep water continued through the upper Devonian, the dip of the strata will diminish as we ascend in the series, and the tendency of one who depended upon a general rate of dip would be to reckon the more southern deposits too high. Professor Williams has good evidence that this has been done for the sands of Wyoming and Alleghany counties.

Professor Williams's observations lead him to the opinion (which may be modified by further facts), that the sandstones lying at the top of the series at Portage Falls, barren of fossils so far as reported, are, when taken as a mass, stratigraphically identical with the lower Chemung sandstones farther south and west, and that geographical conditions had more to do with the presence or absence of the Chemung fauna than had the geological time of the deposit, after once the Chemung fauna appeared in the sea.

The present stage of Professor Williams's investigations leads him to the following opinion as to the distribution of faunas at this mid-upper Devonian for the eastern area: —

1. A Hamilton fauna coming in from the east and north, and extending around the southern border of the old paleozoic continent into the interior sea, through Canada West, Michigan, etc., to Iowa, etc.

2. A black slate fauna, at first reaching quite to the eastern New York areas, but, with the advance of time, oscillating back and forth, each stage withdrawing farther and farther to the west and south.

3. A sparse Portage fauna, mainly small lamellibranchs and pteropods and cephalopods, rather pelagic in character, common over the New York area, but whose centre or origin he is unable to trace.

4. A Chemung fauna from the south and east, pushing northward with the withdrawal of the Hamilton fauna, mingling with it at first in eastern New York areas, but in western New York not appearing at all until the complete withdrawal of the Hamilton fauna.

There are also traces of a fifth fauna over this region; for, as the Chemung fauna is followed towards the western part of the state, species characteristic of the subcarboniferous of the interior begin to appear, both in the nature of the varietal modifications of the species and in the rare new forms mixed with the Chemung species, leading to the suspicion that the subcarboniferous faunas of the western interior may have been contemporaneous with the Chemung faunas of New York and Pennsylvania. He says, however, that the solution of this problem must be left until a more thorough study of the western interior deposits and their faunas is made, and that the problems involved are too complex to make hasty generalizations safe.

These investigations have been partly in the line of some remarks made by Professor James Hall in the 'Paleontology of New York' (vol. iv. part i., March, 1867, p. 257), where he speaks of the diminution of Devonian types and the augmentation of carboniferous types in the same beds in western New York, and also expresses the opinion that the mingling of Devonian and carboniferous aspects is due to geographical and physical conditions, and not to difference in age or chronological sequence of the beds which contain the fossils. Professor Williams is elaborating this idea, and is dissecting the faunas and tracing them to their centres of distribution.

NOTES AND NEWS.

PROFESSOR SYLVESTER, who has resigned the chair of mathematics at the Johns Hopkins university, and has been appointed to the Savilian professorship of geometry at the University of Oxford, sailed for Europe on Saturday last, Dec. 22. The night before his departure from Baltimore, a farewell assembly was held at the university in his honor. Mr. Matthew Arnold, who was present, made a brief speech. Resolutions were read on behalf of the board of trustees and of the teachers in the university, expressing their profound regret at the departure of Professor Sylvester, and the highest appreciation of his work and of the great stimulus his presence has given to mathematical research in this country. Professor Sylvester responded in a speech of characteristic warmth and *naïveté*, in which, along with most enthusiastic admiration and approval of the university he has helped to inaugurate, he took the opportunity of making some pointed suggestions. One of these was addressed to millionnaires, to whom he indicated several ways in which, while aiding the Johns Hopkins university, they might secure for themselves imperishable fame. Another pointed at the advisability of introducing a system of pensions or some equivalent provision for superannuated and disabled professors; and still another was a protest against the dismemberment of a university library by the establishment of specialized branches. Professor Sylvester's departure removes from the university not only the most distinguished scientific man, but the most interesting personality connected with it; and his absence will make a gap in the general life of the university no less than in his own department. It is hardly to our credit that no American college has conferred an honorary degree upon him during his residence in this country.

— In his recent address to the Royal society, President Huxley states that thirty-eight of the Challenger reports have been published, forming eight quarto volumes, with 4,195 pages of letter-press, 488 lithographic plates, and other illustrations. Thirty-four of these memoirs are on zoölogical, four on physical, subjects. Nine reports are now nearly all in type, and some of them partly printed. These will be published within three months, and will form three zoölogical volumes with 230 plates and many woodcuts, and one physical volume with many diagrams and maps: this latter volume will contain the report on the composition of ocean water, the specific gravity and temperature observations. A considerable part of the general narrative of the cruise is now in type, and nearly all the illustrations are prepared. The narrative will extend to two volumes; and it is expected they will be ready for issue in May or June, 1884. The work connected with the remaining forty-two special reports is in most instances progressing satisfactorily. Portions of the manuscript for three of the larger memoirs have been received and put in type, and the manuscript of many others is in a forward state. For these memoirs, 386 lithographic plates have been printed off and delivered to the binders, 404 others are now on stone, and the drawings for many more are being prepared. It is estimated that the whole work connected with the report will be completed in the summer of 1887.

— Professor Huxley also expresses a regret that the admirable energy of the government in taking measures to make the recent advances of medical science available during the late outbreak of cholera in Egypt was not extended beyond the purely practical side of the matter, or perhaps not so far as the practical side in the proper sense; for, until we know something about the causes of that terrible disease, our measures for prevention and for cure will be alike leaps in the dark.

Those, he says, who have looked into the literature of cholera may perhaps be disposed to think that a new search after its cause will add but another to the innumerable wild hypotheses which have been set afloat on that topic; and yet devastating epidemics, like the pebrine of the silkworm, so similar in their fatality and their apparently capricious spread that careful investigators have not hesitated to institute a detailed comparison of the phenomena of this disease with those of cholera, have been proved by Pasteur to be the work of microscopic organisms; and hardly less fatal epidemics, such as splenic fever, have been traced to similar agencies. In both these cases, knowledge of the causes, and of the conditions which limit the operation of the causes, has led to the invention of effectual methods of cure. And it is assuredly, in the present state of science, something more than a permissible hypothesis, that the cause of cholera may be an organic living materies morbi, and that the discovery of the proper curative and prophylactic measures will follow upon the determination of the nature and conditions of existence of these organisms.

If this reasoning is just, it is certainly to be regretted that the opportunity of the outbreak of cholera in Egypt was not utilized for the purposes of scientific investigation into the cause of the epidemic. There are able, zealous, and courageous young pathologists in England who would have been willing enough to undertake the labor and the risk; and it seems a pity that England should leave to Germany and to France an enterprise which requires no less daring than arctic or African exploration, but which, if successful, would be of a thousand times more value to mankind than the most complete knowledge of the barren ice-wastes of the pole or of the sweltering barbarism of the equator. It may be said that inquiries into the causation of cholera have been for some years conducted in India by the government without yielding any very definite result; but this is perhaps rather an argument in favor of, than against, setting fresh minds to work upon the problem.

— Professor George Davidson read papers at the meeting of the California academy of sciences, Nov. 5, on the solar eclipse of Oct. 30, 1883, and the appearance of Saturn as seen at the Dearborn observatory under very favorable conditions. He said of the latter, "The evening was clear and pleasant, and nearly calm. . . . The atmosphere was charged with aqueous vapor, and the dew ran down the observatory almost like rain. . . . But one of the best revealed features . . . was the undoubted difference in brightness of the gauzy ring at the two ansae. The preceding part was decidedly brighter than the following ansa. . . . I should mention, that, in my limited experience in examining Saturn, I have never seen the atmospheric conditions so nearly perfect as they were that night. . . . I saw more than is given in the beautiful Cambridge drawing."

Professor Davidson also spoke of a brilliant meteor as follows: "On the evening of Oct. 29, at eleven o'clock, a remarkably brilliant meteor passed vertically downwards very near to Eridani (3 mag.). It illuminated the street, and its light cast a strong shadow. The train, about five degrees long, was persistent for three or four seconds, with an intense, vivid brightness, then faded away to a white, vaporous-looking streak, which assumed a wavy motion for three or four seconds, and then vanished. The color was an intense white, tinged with a purplish hue; and the brightest part of the train which was left was not at the point of disappearance, but about the middle of its length."

At a later meeting of the academy, Professor Davidson spoke of Trouvelot's red star, seen during the solar eclipse of May 6, and took the ground that δ Arietes was the star seen by Trouvelot.

Full accounts of all these papers were given in the *Mining and scientific press*, San Francisco.

— We take the following account of the awards of medals recently made by the council of the Royal society from Professor Huxley's presidential address: —

The number, the variety, and the importance of Sir William Thomson's contributions to mathematical and experimental physics are matters of common knowledge; and the fellows of the society will be more gratified than surprised to hear that the council have this year awarded him the Copley medal, — the highest honor which it is in their power to bestow. Sir William Thomson has taken a foremost place among those to whom the remarkable development of the theory of thermodynamics and of electricity in the last forty years is due. His share in the experimental treatment of these subjects has been no less considerable; while his constructive ability in applying science to practice is manifested by the number of instruments bearing his name which are at present in use in the physical laboratory and in the telegraph-office. Moreover, in propounding his views on the universal dissipation energy and on vortex motion and molecular vortices, Sir William Thomson has propounded conceptions which belong to the prima philosophia of physical science, and will assuredly lead the physicist of the future to attempt once more to grapple with those problems concerning the ultimate construction of the material world which Descartes and Leibnitz attempted to solve, but which have been sedulously ignored by most of their successors.

One Royal medal has been awarded to Dr. T. Archer Hirst, F.R.S., for his investigations in pure geometry, and more particularly for his researches into the correlation of two planes and into the complexes generated by them.

The other Royal medal has been awarded to Dr. J. S. Burdon Sanderson, F.R.S., for the eminent services which he has rendered to physiology and pathology, and especially for his researches on the electrical phenomena exhibited by plants, and for his investigations into the relation of minute organisms to disease. In making this award, the council desire not merely to recognize the merit of Dr. Burdon Sanderson's researches, especially those on the analogy between the electrical changes which take place in the contractile tissues of plants and those which occur in the like tissues of animals, but to mark their sense of the important influence which Dr. Sanderson has exerted upon the study of physiology and pathology in this country.

The Davy medal has this year been again awarded in duplicate; the recipients being M. Marcellin Berthelot, member of the Institute of France, and foreign member of the Royal society, and Professor Julius Thomsen of Copenhagen. The thermochemical researches of Berthelot and Thomsen have extended over many years, and have involved an immense amount of work, partly in the application of established methods to new cases, partly in devising new methods and applying them to cases in which the older methods were not applicable. Chemists had identified a vast variety of substances, and had determined the exact composition of nearly all of them; but of the forces which held together the elements of each compound they knew but little. It was known that certain elements combine with one another with great evolution of heat-forming products in which they are firmly united; while other elements combine but feebly, and with little evolution of heat. But the materials for forming any general theory of the forces of chemical combination were but scanty and imperfect. The labors of Messrs. Berthelot and Thomsen have done much towards supplying that want, and they will be of the utmost value for the advancement of chemical science.

— Dr. Charles W. Dabney, director of the North Carolina agricultural experiment-station, has issued a circular urging the necessity of a strictly scientific agricultural journal in this country, either a quarterly or monthly. Those interested should address Dr. Dabney at Raleigh, N.C. The station at Raleigh is reported to be in a prosperous condition.

— The next number of the *Journal of the Cincinnati society of natural history* will contain a biographical sketch and a steel-plate portrait of the late V. T. Chambers, the entomologist. Mr. Chambers was at one time president of the society, and at all times one of its most active members.

— The Ohio mechanics' institute of Cincinnati has inaugurated a series of popular scientific lectures on a plan pursued in former years. The lecturers and the topics for this series are as follows: Prof. T. C. Mendenhall, 'The electric light;' Prof. C. L. Mees, 'Molecular motion and crystallization;' Prof. F. W. Putnam, 'Ancient arts of North-American nations;' Dr. A. Springer, 'The cell and its functions;' Prof. E. S. Morse, 'Japan;' Prof. Thomas French, jun., 'Sound;' Prof. W. L. Dudley, 'Water;' Prof. T. H. Norton, 'Recent advances in chemical technology;' Prof. J. B. Porter, 'Mining and metallurgy.' The first two of these have already been given. The others will follow at intervals of about two weeks.

— The course of free popular scientific lectures just concluded by the Cincinnati society of natural history was a great success. Eight lectures were delivered on topics connected with zoölogy by members of the society. They were given every Friday evening from Oct. 19 to Dec. 7, and were attended by as large audiences as the lecture-room would accommodate. The lecture committee is arranging for another course, to begin on Jan. 4; and these lectures will treat of topics connected with geology and mineralogy. 'Gems,' 'Marbles and corals,' 'Physical geography of the United States,' and 'Fossil botany,' are some of the subjects. The officers of the society deserve credit for their efforts to make the institution of practical educational value.

— It is proposed to hold during the year 1884, says *Nature*, an international exhibition, which shall also illustrate certain branches of health and education, and which will occupy the buildings at South Kensington erected for the fisheries exhibition. The object of the exhibition will be to illustrate, as vividly and in as practical a manner as possible, food, dress, the dwelling, the school, and the workshop, as affecting the conditions of healthful life, and also to bring into public notice many of the most recent appliances for elementary school-teaching and instruction in applied science, art, and handicrafts. The influence of modern sanitary knowledge and intellectual progress upon the welfare of the people of all classes and all nations will thus be practically demonstrated, and an attempt will be made to display the most valuable and recent advances which have been attained in these important subjects. The exhibition will be divided into two main sections, — I. Health; II. Education,— and will be further subdivided into six principal groups. In the first group it is intended specially to illustrate the food-resources of the world, and the best and most economical methods of utilizing them. For the sake of comparison, not only will specimens of food from all countries be exhibited, but the various methods of preparing, cooking, and serving food will be practically shown. The numerous processes of manufacture connected with the preparation of articles of food and drink will thus be exemplified; and, so far as the perishable nature of the articles will admit, full illustrations will be given of the various descriptions of foods themselves. In the second group, dress, chiefly in its relation to health, will be displayed. Illustrations of the clothing of the principal peoples of the world may be expected; and a part of this exhibition, which, it is anticipated, will be held in the galleries of the Royal Albert Hall, will be devoted to the history of costume. In the third, fourth, and fifth groups will be comprised all that pertains to the healthful construction and fitting of the dwelling, the school, and the workshop, not only as respects the needful arrangements for sanitation, but also the fittings and furniture generally in their effect on the health of the inmates. The most improved methods of school construction will be shown; and the modes of combating and preventing the evils of unhealthy trades, occupations, and processes of manufacture, will form portions of the exhibition. The sixth group will comprise all that relates to primary, technical, and art education, and will include designs and models for school-buildings, apparatus and appliances for teaching, diagrams, text-books, etc. Special attention will be directed to technical and art education, to the results of industrial teaching, and to the introduction of manual and handicraft work into schools.

— The members of the polar meteorological station which Denmark maintained at Godthaab in Greenland have just returned to Copenhagen. According to *Nature*, the chief of the expedition, Lieut. A. Paulsen, reports, that, having left Copenhagen on May 18, 1882, in the sailing-ship Ceres, they arrived at Godthaab on June 14. On the voyage out, observations of the temperature of the sea and air were made every hour. On the arrival out, the expedition had to select the most suitable spot for the erection of the four wooden buildings brought with them, in which the magnetic and astronomical observations were to be made. A small mountain ridge near the church in the colony was chosen for this, as the preliminary researches in its neighborhood showed that the influence of iron strata on the magnetic current was here very small. The buildings were then erected, and the pillars raised on which the transit instrument, the great astronomical clock, and the eight different magnetical instruments, were mounted, and simultaneously the instruments for the meteorological observations were also placed; so that the weathercock and the anemometers, as well as the thermometer hut, were situated as free as possible. On Aug. 1 the meteorological observations could be commenced, but the magnetic ones were through an accident delayed until the 7th. From that date complete observations were made in exact accordance with the international programme, without interruption, every hour until Aug. 31 this year; and the expedition has thereby fully accomplished its object, viz., of obtaining a full year's magnetical and meteorological observations in this locality. A number of other scientific researches have also been pursued, of which those on the aurora borealis should particularly be mentioned. This phenomenon was frequently observed and studied during the winter, while some exceedingly valuable statistics were obtained as to the altitude of the aurora borealis above the earth's surface by measurements effected simultaneously in various places by light-signals. The measurements of atmospheric electricity have also led to valuable results. It is stated to have been the best equipped polar expedition ever despatched from Denmark.

— M. Laugier, at a meeting of the Académie des sciences held on Oct. 22, described a method of disinfecting plants for exportation, practised by himself and Dr. Koenig at Nice. Some branches of vine infected with phylloxera were treated with a solution of sulphocarbonate of ethyl, the eggs and phylloxera being completely destroyed. The plants submitted to the trial do not seem in general to have suffered from it. For the first trials in disinfecting leaves and twigs, gaseous hydrocyanic acid was used, as proposed by Dr. Koenig; and for the roots and surrounding earth, sulphocarbonate of potassium in weak solution. Their experiments, they believe, will be of great service to the flower-cultivators of the Riviera.

— The distinguished French geodesist, M. Antoine d'Abbadie, writes to the editor of *Nature*, regarding units of angular measure, as follows: —

"We probably owe our degrees either to the earlier supposed year of 360 days, or to the fact that this number has many divisors, although such divisors afford no practical advantage. When trigonometrical functions were subsequently discovered, it was found that the natural unit is not the circle, but the quadrant or right angle. Our system of numeration being decimal, it was then most convenient to divide the quadrant decimally; and the circle is thus considered as composed of four, forty, four hundred, etc., parts, according to the degree of exactness required. This was proposed by Briggs when preparing his logarithms, which are based on decimals; but unfortunately it was then set aside. Revived a long time after by Lagrange, it was acted upon by Laplace in his Mécanique celeste. Nowadays decimal divisions of the quadrant are the only ones used by French geodesists. . . . In Italy two geodesists were instructed to observe and calculate, in both the centesimal and the sexagesimal systems, the same large lot of angles. It was then found that the use of decimals gave a saving of two-sevenths of time, either in observation or in calculation. This result was unknown to Sir George Airy; but he judged rightly that the conversion of all sexagesimal angles into decimal ones would materially lighten his labors, and he actually did so when calculating all the lunar observations previously made at Greenwich."

— Prof. H. G. Van de Sande Bakhuyzen, the director of the observatory at Leiden, announces the completion of a new catalogue of star-places (began by Hoek, and continued by Dr. Kam, and contained in the first sixty-six volumes of the *Astronomische nachrichten*). The catalogue will contain nearly five thousand stars, reduced to the epoch 1855.0, with the data pertaining to the observations, and the usual elements for carrying forward the star positions.

— The last expedition of Lessar toward the Oxus was attended with severe hardships. He lost nearly all his animals; and to save his famished escort, almost destitute of water and provisions in the desert, he was obliged to seek assistance from the Khivans. Worn with three years painful and continual exploration, the explorer thinks of returning to Europe.

INDEX TO VOLUME II.

*** *Figures in black-faced type refer to the numbered paragraphs in the 'weekly summary;' those in ordinary type, to pages. Names of contributors are printed in small capitals.*

ERRATA.

Page 61, col. 2, 5th line from bottom, for 'Alongshore, winds' read 'Along-shore winds.'
" 146, " 2, 5th line from bottom, for 'Ayres' read 'Ayers.'
" 199, " 2, line 13, for 'twenty-five hundred' read 'six hundred and ninety.'
" 250, " 2, last line of first article, for '3.37039 inches' read '3.37027 inches.'
" 395, in inscription of cut, for 'August' read 'July.'
" 403, col. 1, line 28, for 'Tusell' read 'Torell.'
" 403, " 1, " 34, for 'lithogical' read 'lithological.'
" 403, " 1, " 43, for 'Irving in' read 'Irving on.'
" 426, " 1, " 11, for 'similar' read 'only.'
" 430, " 1, " 12, for 'poorer oxidizing' read 'oxidizing power.'
" 430, " 1, " 32, for 'Purzgau' read 'Pinrzgau.'
" 459, " 2, " 25, for 'refine' read 'define.'
" 465, " 2, " 10 of second article, for 'Koblanck' read 'Koblank.'
" 466, " 2, " 13, for 'practical' read 'practised.'
" 467, " 1, " 38, for 'of the surface' read 'on the surface.'
Page 467, col. 2, 11th line from bottom, for 'in the crayfish' read 'on the crayfish.'
" 468, " 1, line 19, for '0.145 inch' read '$\frac{1}{145}$ inch.'
" 468, " 2, " 1, for 'an angle' read 'air angle.'
" 468, " 2, " 32, for 'Clevinger' read 'Clevenger.'
" 469, " 2, " 5, " " " "
" 471, " 2, " 8, for 'Mieham' read 'Mecham.'
" 483, " 2, 4th line from bottom, for '5 μ' read '.5 μ.'
" 523, " 2, last line, for 'Ifuagos' read 'Ifugayos.'
" 540, " 2, line 15 of second article, for 'Z. cavisortris' read 'Z. cavirostris.'
" 556, " 1, " 23, for '90°' read '45°.'
" 569, " 2, last line but one, for 'San Joan' read 'San Juan.'
" 570, " 1, line 18, for 'or Vancouver' read 'on Vancouver.'
" 607, " 2, " 9, for 'catalogue of mollusks' read 'catalogue of his collection of mollusks.'
" 701, " 2, note, for 'No. 42' read 'No. 41.'
" 722, " 2, " 38, for 'Hectariniinae' read 'Nectariniinae.'
" 735, in inscription of cut, for '1876' read '1870.'
" 802, col. 1, line 38, for 'Lanicera' read 'Lonicera.'
" 838, " 2, " 11, for 'Dearborn' read 'Davidson.'

SCIENCE

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CHEAP FOOD FOR THE MILLION.

BY CHARLES S. BRAY, M.D.

[*From "The Century Magazine" for July.*]

I. INIQUITOUS ADULTERATION.

"There has been so much adulteration of food," said a New-York divine recently, "that it is an *amazement to me that there is a healthy man in America.* The great want of to-day is practical religion, — a religion that will correctly label goods, that will prevent a man telling you a watch was made in Geneva when it was made in Massachusetts, that will keep the ground glass and the sand out of the sugar, that will go into the grocery and pull out the plug of ale-adulterated sirup, that will dump in the ash-barrel the cassia-buds that are sold for cinnamon, that will sift out the Prussian-blue from the tea-leaves, that will keep out of flour the plaster of Paris and soapstone, that will separate the one quart of Ridgewood water from the one honest drop of cow's milk, that will throw out the live animalculae from the sugar. Heaven knows what they put in the spices, in the butter, or the drugs; but chemical analysis and the microscope have made wonderful discoveries."

"The Youth's Companion," in a recent article on the adulteration of food, says, —

> "A system of inspection is necessary to protect the public from the adulteration of food which is so common in this country, especially in the poorer quarters of our large cities, where the prices are low and the purchasers not fastidious. . . . Large quantities of unwholesome meat are sold to the poor, such as poultry which has been thrown out of the better class of markets, 'bob' veal, the meat of calves killed too soon after birth, and beef that comes from animals that have been unhealthy before slaughtering. . . . The health of a community can be seriously injured by the tricks of dishonest tradesmen, and people should be careful in buying food that is offered at unusually low prices."

These strictures may, perhaps, strike the average reader as foreshadowing a crusade against the compounders and venders of adulterated food; but this is not our prime object. The combined power of the pulpit and press is almost incalculable, and the batteries of the latter are being levelled against this "common enemy" along the whole line. That men, induced by the hope of gain, should adulterate the staples of life, and thus add crime, and, as often follows, murder, to their account on the "Great Ledger" of eternity, seems almost impossible of conception: and yet it is only too true. This criminal practice is as old as the hills; and its recent condemnation by the clergy and press is only another exemplification of the value of free speech and a free press, — two inestimable boons to Americans.

II. SPOILED FOOD.

It is a fact, lamentable enough in itself, that food has a natural tendency to decay, which men have heretofore unsuccessfully attempted to check. Especially is this true of animal food and its after-products, such as butter, cream, milk, cheese, lard, etc. The problem of pure, fresh, healthful, cheap food, in all climates and seasons, is a field broad enough to command the attention of all philanthropists. To the rich man all things seem possible; but to the laboring classes this problem of fresh and cheap food is, and ever has been, a veritable Gordian knot.

The laboring man looks forward to Sunday for a day of rest and a good dinner. The steak, oysters, chop, chicken, and such delicacies are procured on Saturday, and kept over for this sabbath meal. It goes without saying, that a lack of ice, a warm room, a muggy day, a poorly ventilated cellar, and a myriad of such every-day causes and circumstances, conspire to spoil these viands. Even slightly salted, they lose their fresh flavor; smoked, they are even less desirable; immersed in pickle, or corned, they become impregnated with the deadly saltpetre; placed in a refrigerator, they are practically frozen.

"All such food is injurious to health," says a learned Cincinnati judge; yet, left alone to the influences of climate, weather, and natural surroundings, they speedily spoil. What, then, shall rich or poor do to insure the coveted luxury of fresh, healthful food?

The problem has been a knotty one since the advent of man upon this terrestrial planet. The criminal cupidity of many dealers, on the one hand, and the hosts of natural causes of decay, and man's inability to find a reliable, safe, and cheap food-preservative, on the other, are obstacles which have always heretofore confounded the world.

III. FOOD-PRESERVATION.

One of the largest elements of risk in general farming and in dealing in food-products is the loss on perishable goods, both from decay and deterioration, as well as from the frequent necessity of forcing such goods upon an overstocked market at ruinously low prices. The world has long needed some substance, at once harmless and efficient, to maintain in their production that freshness and sweetness in provisions so essential to remunerative returns. Salted meats are distasteful to many, and repugnant and unhealthful to all, where a regular diet of such material is maintained. Once salted, a piece of beef is immediately lowered in value. Millions of dollars' worth of poultry, lamb, veal, and mutton are annually lost to the world through the lack of practical means of preservation. Milk and cream cannot be kept longer than a day or two, and tons of butter every year become rancid and are sold for grease. The want of a thing always directs scientific inquiry and inventive genius toward its discovery. It has been known for many months past, in commercial and scientific circles, that this important discovery had been made in a food-preservative by Prof. R. F. Humiston of Boston. A series of experiments was conducted to prove beyond a doubt the success of his invention, which resulted most satisfactorily to a number of leading capitalists and scientific men, who determined to bring it before the public in a large commercial way.

Professor Humiston must hereafter go down to posterity as an inventor or discoverer as great as Franklin, Morse, Fulton, or Sir Humphry Davy, and for the sufficient reason that he has, after long and patient years of study and research, with thousands of experiments, discovered and perfected a combination of antiseptics, harmless in their nature, which is a *perfect* substitute for ice, salt, sugar, smoke, heat, alcohol, sulphur, — all the agents, indeed, hitherto employed by man in attempting to save food. By the use of this preservative — which has been happily named "Rex Magnus" (for it is indeed the "great king" of preservatives) — all organic matter can be preserved from decay without the use of any of the agents above enumerated.

The process is cheap, simple, and perfect; and the results are certain, regardless of seasons or climates.

IV. THE NEW PROCESS.

In brief, the new process is based upon truly scientific principles, perfectly adapted to the preservation of a great variety of animal and vegetable products. The basis is a tasteless, innocuous white powder, which is dissolved in water, forming a solution in which the beef, or turkey, or mutton is immersed and treated, or which may be injected into the carotid artery of large animals as soon as the blood ceases flowing. By this simple and inexpensive process, the article thus treated may be hung up in ordinary temperature, remaining sweet and wholesome for an indefinite term. Upon the closest scrutiny and the most practical and exhaustive experiments, certain well-known business gentlemen of Boston and vicinity have associated themselves into a corporation, under the name of The Humiston Food-Preserving Company, choosing Mr. J. Willard Rice of Boston, of the well-known paper firm of Rice, Kendall, & Co., as their president, and Dr. R. C. Flower, secretary and treasurer. This company has established a large manufactory at Salem, Mass., with a daily capacity of five tons of Rex Magnus, and their headquarters at 72 Kilby Street, Mason Building, Boston, where may be seen and examined a most interesting exhibit of fish, fowl, game, beef, mutton, and like perishable articles of food, treated with Rex Magnus, and exposed to the atmosphere of a business office, and to the rays of the sun.

The public will naturally wish to know the means or the action by which this Humiston food-preservative performs its important work. In fact, the question is already asked, "Why is it that this preserves, perfectly sweet and pure, for an indefinite period, meats, fruits, vegetables, milk, butter, etc.?"

It is the office of Rex Magnus to oppose and prevent putrefaction by the utter destruction, or holding at bay, of those parasites that prey upon organic matter. Meats, poultry, game, cream, milk, or oysters, preserved by this method may be carried across the continent, or shipped to Europe, retaining their freshness and purity without the use of ice or any refrigerating appliance, or they may be kept at home for days and weeks, even in the hottest weather, improving in taste, besides saving much expense in the cost of ice, and time and trouble in going to market. There is ample testimony that these are stubborn facts. It is infallible in its power to preserve, of great strength, and concentrated in form, tasteless and unobjectionable to the palate, harmless in its effect upon the human system, and, finally, capable of almost universal and simple application to such food-substances as are subject to speedy decay. The food treated with Rex Magnus carries no unusual or unnatural taste. Its use is so simple that a child may direct the operation of preserving food. The article to be preserved may be wrapped in cloths wet in the solution, and occasionally redampened, or it may be plunged into a tub or jar full of the solution, and allowed to remain for several hours. The powder may be worked into butter at the time of making, or the balls of butter may be placed in vessels filled with the solution, and allowed to remain for weeks and months. Dairymen have preserved butter with all the freshness and aroma of the June product for six months, and Professor Humiston has preserved eggs entirely fresh and sweet for fourteen months at a time.

V. THOROUGHLY INDORSED.

It has been subjected to the most severe and thorough tests, both by scientific, medical, and business men. Professor Samuel W. Johnson of Yale College, after testing it to his entire satisfaction, made a report, in which he says,—

"My tests of thirty-five days, in daily mean temperature of 70°, on meats, etc., bought in open market, have certainly been severe; and I am satisfied that the different brands of Rex Magnus, The Humiston Food-Preservative, with which I have experimented, *have accomplished all claimed for them.* So far as I have yet learned, *they are the only preparations that are effective and at the same time practicable* for domestic use. At the banquet on 'treated' meats at the New-Haven House, *I could not distinguish between those which had been sixteen days in my laboratory and those newly taken from the refrigerator of the hotel.* The oysters were perfectly palatable, and fresh to my taste, and better, as it happened, than those served at the same time, which were recently taken from the shell. The roast beef, steak, chicken, turkey, and quail *were all as good as I have ever eaten.* I should anticipate *no ill results* from its use, and consider it *no more harmful than common salt.*"

Rex Magnus is a valuable discovery, a boon to agriculturists, a legitimate business enterprise. It is not to be classed for a moment with the numerous humbugs of the past,—ozone, and a host of such, the impossible projects of scheming men or the visionary dreams of laboratory scientists. Professor Humiston has devoted many years to studying to assist the millions to get cheap food, and, as the great aid to this end, made intense application and active research in the matter of antiseptics alone. He perfected his process, he proved his theories, he demonstrated the feasibility of his methods, he enlisted his co-operators, he secured the necessary capital, the company was organized, who bought extensive works, and they commenced on a commercial basis before they took measures to inform the publc of this wonderful preservative.

VI. A BUSINESS BASIS.

This company is not seeking capital of the public: they simply propose to manufacture this preservative on a large scale, to offer it for sale eventually in every grocery and provision store in the land in large or small packages. All classes now have an opportunity of purchasing the preservative in small and inexpensive packages, and of testing, each for himself, its value in his own home and business. There is no opportunity or design for any misrepresentation or serious disappointment in a fair, open transaction like this. There are no territorial rights or patent licenses for sale, but every one may have equal and ample chance to use Rex Magnus. The company offer, however, to supply any one—in case his grocer, druggist, or general storekeeper hasn't it on hand—with any brand of Rex Magnus which he may desire, upon receipt of the price. They will prepay postage charges on *sample* packages, which cost but fifty cents per pound for meats, milk, and sea-food, while cream and other special brands cost one dollar per pound.

VII. PREVIOUS FAILURES.

The wretched failures by which the public has heretofore been deceived have pretended to preserve all kinds of food with the same compound,—an idea which is preposterous on the face of it. Meat is different in character and substance from sea-food, and this from milk, cream, and butter, these from eggs, and eggs from vegetable juices or fluid extracts Professor Humiston has treated the subject in a scientific way. Having thoroughly investigated the question of antiseptics, he found the properties and chemical analyses of the different kinds of food, and then, after thousands of experiments, having fully learned what antiseptics and what proportions were best adapted for each, he compounded his preparations intelligently, each to the purpose for which it is especially designed. Herein lies his success, and it is herein that all others have failed.

VIII. HIGH TESTIMONY.

The famous Miss Juliet Corson, in a recent article in "Harper's Bazar," on "Diet for Invalids," and treating especially of game and poultry, says, —

"While the general rule holds good, that fresh food is the most wholesome, and that actual decay in animal flesh used for food is apt to produce symptoms of irritant poisoning, game is often eaten in an advanced stage of decomposition without any perceptible injury to the epicure. Microscopic examination of meat which has been exposed to a medium summer temperature from 85° to 90° Fahrenheit, for three or four days, proves the development, at that stage, of a minute organism, termed by physiologists the death vibrio. This parasite seems to be present in other meats than pork, and, like trichinæ, is not destroyed by the process of salting and smoking meat, or of curing it in brine. There is no reason to suppose that the flesh of game is exempt from the presence of this natural product of decomposition. When meats containing it are imperfectly cooked, their consumption produces gastric disturbance, sometimes fatal in its result. As game is generally broiled or roasted, the action of intense heat may destroy the septic influence of the organism.

. . . .

"I have considered this rather unpleasant subject at length with the hope that when game is ordered for an invalid the caterer may be induced to supply it as fresh as possible. As a rule, the flesh of game is less dense and tough than that of domestic animals, so that there is not the same reason for keeping it, in order to let it become tender by the first action of decomposition. Game is also more digestible than butcher's meat, and for that reason may be eaten fresher. Its comparative freedom from fat makes it relatively more nutritious, while its intense flavor is tempting to the appetite. As the taste of the flesh and blood of game is nearly identical, the latter is generally carefully preserved in cooking."

It is in such cases as referred to by Miss Corson that Rex Magnus plays a most important part. It is of the utmost moment that the food of invalids, as well as of people in good health, should be tempting in quality and appearance, appetizing in flavor, and tender and easy of mastication; but at the same time, and above all, it must be perfectly sweet and fresh. Special care must also be taken that the living creature from which it is derived was in a perfect state of health, as otherwise germs of disease may be taken into the weak and enfeebled system, which perhaps would have no detrimental effect upon a state of health. Rex Magnus will, as we have already shown, enable invalids and others to keep meats, wild game, and other like delicacies, in a condition perfectly sweet and fresh for any reasonable time: sweet-breads have been kept four months, and cream nearly as long, and both sweet, and known as difficult to keep. Game can be treated with it when first killed, and then shipped to market; or, by taking care to purchase only that which is sound and good, it can be treated at home, and then kept until wanted, improving in quality, and growing more tender, digestible, and wholesome. It goes farther, and is of even greater value to the million as a preventive of disease and an aid to health. It not only arrests and prevents decay, and thereby obviates the danger of eating partially decomposed food, but it counteracts and destroys any hidden germs of disease, and renders all articles treated by it wholesome and harmless. In this respect it is a great boon to mankind.

Professor Humiston is a little over fifty years of age, is a native of that grand old town, Great Barrington, Mass. He received his M.A. at the Western Reserve College. He has the honor of being a Fellow of the Chemical Society of London, and also of the Geological Society, being elected after unusually severe examinations. President Huxley, of the latter society, said that "no American should boast of an election without a hard struggle." In evidence of this prejudice toward Americans, the fact that Professor Humiston was given two hundred and fifty questions — five times the usual number — may be cited. He is now superintendent of the company's works, which will insure the most careful product for this "mighty king" of food-preservatives. This company is meeting with great success, and deservedly.

THE ART OF BOOK-BINDING.

BY HENRI PÈNE DUBOIS.[1]

A VERY curious essay might be written on the history of book-binding, the fascinating department of the bibliomania which immortalized Grollier.

At the beginning, it was the art of goldsmiths and enamellers: and books were adorned with a silver cover, gilt, and precious stones. In Chaucer's time the fashionable binding was various-colored velvet, as in the Prologue to the "Canterbury Tales:" —

> "A twenty bokes, clothed in black or red,
> Of Aristotle."

And it was not until the close of the fifteenth century that the usual ornaments of silver, and massive clasps, and thick metalled corners, were discarded.

They were destined to render a book impervious to external injury; but in the wooden covers the worm was secretly engendered, and its ravages attest the defectiveness of ancient binding. Mr. Roscoe wrote eloquently in commendation of it, however, in his "Lorenzo de Medici:" "A taste for the exterior decoration of books has lately arisen in this country, in the gratification of which no small share of ingenuity has been displayed; but, if we are to judge of the present predilection for learning by the degree of expense thus incurred, we must consider it as greatly inferior to that of the Romans during the time of the first emperors, or of the Italians at the fifteenth century. And yet it is difficult to discover why a favorite book should not be as proper an object of elegant ornament as the head of a cane, the hilt of a sword, or the latchet of a shoe."

The prejudice in favor of ancient binding was displayed as recently as in the report of the international book-binding exhibition of 1857, wherein the judges, Merlin, Capé, and Bauzonnet, expressed the opinion advanced by Roscoe. They went farther than this in their extollation of the masters of the three preceding centuries, especially of those whom, as Dibdin would say, St. Jerome or St. Austin would have lashed for the gorgeous decorations of their volumes. But there was a feature in that exhibition of special interest to American bibliophiles.

Holland (once famous for its bindings of vellum), Germany (whose gilders had been constantly employed by the binders of France), Spain, and Italy exhibited nothing but copies of the declining French art.

The rivalry existed between France and England. France excelled in taste and finish, but at some sacrifice of flexibility; while in England the soft and coaxing manner in which, by the skill of Herring or Mackinlay, "leaf succeeds to leaf," was spoiled by the tarnishing of the once blazing gilt edges.

It became evident to an impartial observer that the decline of the art of book-binding was due to the apathy of the book-collectors.

It owed its existence to them, and to them only; and they, too, were responsible for its decadence. Therefore I presumed little in my estimation of the value of that exhibition to American bibliophiles: it inspired Bradstreets of New York with the thought that the art of book-binding was not to be restricted to one nation, or to one family, as tradition would have it in France, but that it would flourish

[1] This monograph on the art of book-binding is practically a partial reprint of a neat, small pamphlet issued by The Bradstreet Company. A copy of the pamphlet can be had free by addressing The Bradstreet Company at its main offices, No. 279 Broadway, New York, or any of its branch offices throughout the world.

wherever it would find a Mæcenas. Although the art of book-binding is not deteriorating in England or in France at present, — especially is this seen in the fact that in the interval of the past twenty-five years the book-collectors there have rallied to its support, — nevertheless, the American bibliophiles are so increasing in number and in strength, that a good portion of the most valuable books of the European auction-marts are finding their way to this country, many of which have been intrusted to Bradstreets to do the very class of work that bibliophiles were wont, in spite of the most vexatious delays, to send to English and French binders; and now, I should say, deservedly too, because there is a solidity, strength, and squareness of workmanship about the books of the Bradstreets' bindery, which baffle the closest scrutiny. Their gilding, too, is perfect, both in choice of ornament and in splendor of gold. There is no reason for their being of less potent renown than any of their predecessors.

The bibliophiles will appreciate this *de visu*.

The uninitiated should be aware of the qualities that constitute a good binding. It ought to unite solidity with elegance: the volume should open easily, and remain open at any page, the back flexible, and the leaves evenly cut. The gilding and other ornaments should be left to the artist; but the book-collector should supervise the inscription of the title as a precaution against the unfortunate experience of an ardent book-lover whose uncut scarce edition of the works of Brantôme, confided to an artistic but dreadfully provincial bookbinder, was returned to him with the leaves scrupulously cut, and the volumes inscribed as follows: —

Bran *Tome I.*
Bran *Tome II.*
Bran *Tome III.*

and so on to the ninth volume. And Dibdin relates, among anecdotes of barbarous titles applied to precious works, the discovery by a well educated bibliomaniac of the first and almost unknown edition of the "Decameron" of Boccaccio, in a volume entitled "Concilium Tridenti."

Those are primary considerations; but there are others which relate to the expression of the binding of a book. It should be sad or gay, sombre or brilliant, in accord with the tone of the work, its spirit, and its epoch. Didot even insisted upon a refinement in the matter of color, advising chromo-bibliotacts, as they are aptly styled by Uzanne, to clothe their works on theology in purple, astronomy in azure, and travels in marine blue, — presumably in accordance with the good and very appropriate metaphor of the inscription on a king of Egypt's bookcase, "Treasure of the Remedies of the Soul;" books being, like drugs, to be taken with discretion and in various doses, and their outward appearance to denote the nature of the remedy they contain in order that the poison be not mistaken for the antidote.

Thouvenin, as every bibliophile knows, was puffed by Nodier; but he failed to appreciate in his workmanship that evidence of the eternal fitness of things, wherefore his glory is gradually waning. A good point might be made of this in favor of American artists; for no man can put a varied-colored morocco coat upon the back of a book with greater care, taste, and success, than Bradstreets, who are, in fact, the American bibliopegists.

And I do not hesitate to commend their work to that eclectism of the veritable connoisseur, which is not to be affected by *camaraderie*, nor swayed by the dictates of the votaries of fashion.