THE JOURNAL

OF THE

POSTAL MICROSCOPICAL SOCIETY:

A MISCELLANY OF

NATURAL AND MICROSCOPICAL SCIENCE.

EDITED BY

ALFRED ALLEN,

Honorary Secretary of the Postal Microscopical Society,

ASSISTED BY

SEVERAL MEMBERS OF THE COMMITTEE.

VOL. II.

London:
W. P. COLLINS, 157, GREAT PORTLAND STREET.
Bath:
1, CAMBRIDGE PLACE.
1883.

Preface.

THE Season has again arrived when the Editor is, according to time-honoured custom, expected to address a few lines to his readers.

Acting on the advice of our Publisher and numerous friends, parts 7 and 8 of this Journal have been published together; by this slight irregularity we are enabled, not only to complete the volume at the close of the financial year of the Postal Microscopical Society, but we shall also be able to commence our THIRD VOLUME concurrently with all the Quarterly Scientific Periodicals, and trust that this will prove of considerable advantage to our Members and Subscribers generally.

We review the work of the past two years with much satisfaction, feeling assured that the "Journal of the Postal Microscopical Society" is making steady progress, and that the time is not far distant when a copy will be taken by every Microscopist throughout the United Kingdom.

It has occurred to us that the title chosen for our Journal is somewhat too exclusive, appearing to limit the scope of the Articles to one special branch of science, and as we are frequently urged to insert Articles touching other departments of Natural History, and have, indeed, already admitted some into the Journal, we think it not improbable that the third volume may appear with an addition to the old title, but this cannot be decided until the Annual Meeting, which will be held in a few days.

In future issues, as in the past, MICROSCOPY will always occupy the most prominent place; but, at the same time, good Papers on Botany, Entomology, Geology, Photography, etc., will not be excluded.

We do not forget that our original object, in setting on foot this Journal, was to preserve the many valuable Notes of the Members of the Postal Microscopical Society found scattered throughout the Note Books, and also to give an opportunity for their perusal to a much larger circle than our own Members, and we feel that the association of the Journal with the Postal Microscopical Society is a guarantee of the high place it is intended to take amongst the Microscopical and Natural History literature of the day; and, as such, we confidently place it before the public.

We should, indeed, be lacking in gratitude were we not most heartily to thank all our friends, Contributors, and Subscribers, for the help so kindly and courteously given by them, and of which we have received so large a share during the past two years.

The Journal

OF THE

Postal Microscopical Society.

MARCH, 1883.

The Conduct of Scientific Inquiry.

By E. J. E. Creese, F.R.M.S.

I HAVE been led to select as the subject of the present paper "The Conduct of Scientific Inquiry," and for obvious reasons must confine my remarks to but one of its many aspects. I have therefore chosen that relating to the province of the intellect therein. Intellectual sloth still remains one of the sins of society, nor is it lessened by the necessity that impels men to mental activity of a kind required to fulfil the conditions of living. Who has not been struck with the superficial conversation of the London mechanic on his way to business? He takes his seat in a third-class compartment amidst a cloud of broadsheets, his eyes hastily scanning one of them; and when he does pass a remark, it is simply to draw attention to what he has only just read, or to pass a joke that has long since lost its edge by frequency of repetition. He seems utterly unable to suggest thought, and deems it sufficient if he simply becomes just aware of what is going on around him. If you put to him the question, "Why?" or "By what means?" his reply most deplorably reveals that it is certainly not his habit to use his reflective powers, and one unwillingly gets more and more impressed that there is still some truth in the old saying, "In at one ear and out at the other." How many of such men there are in the scientific world! Not that they are destitute of interest in scientific pursuits, but, having alone obtained their knowledge of recent developments of research from summarised newspaper and magazine reports, they unfortunately imagine that it is sufficient for them to follow this method of acquisition to become supplied with an adequate basis for further practical work. It is almost unnecessary to say that self-deception of that kind will but prove a card house whose weakness is the measure of its strength. And yet it suggests a question which may lead to an interesting inquiry, viz., whether those whose natural inclination is towards scientific studies are not often contented with being parasitic; whereas, real love for science may not unfrequently be found where it is least suspected.

I remember some time ago reading in one of Mr. Ruskin's works a reference to true and false art in its influence upon the national mind. He states his view of the work of a true artist to be the daily drawing of simple objects around him, with severe care of truthfulness even at the expense of "finish." The mind of such an one, habituated by truthful representation, becomes quickly sensible of deception, and this imparts a moral tone. Mr. Ruskin then draws an instructive contrast between India and Scotland. Referring to art in India, he says that there the imagination is enthroned and alone bows to itself, natural form being allowed to have no place in it, and the exaggerated forms of the national art—themselves the products of impure imagination—supplying the material for fresh manifestation of degeneracy in the mode of art representation. Thus reduced, its final aid is evoked in the production of deities which the nation, in its moral corruption, is prepared to receive at its hands. Indian art finds its ideal in the product of a distorted imagination which is ever feeding upon itself. In it there is neither inspiration nor incentive; and this, too, in a country so rich in natural scenery, and where true art might be expected to flourish. Scotland, on the other hand, though a country possessing scenery that might justly be termed grand, is not so rich in the kind of beauty that has been so freely lavished upon India. Yet Scotland is in every Scotchman, and his love of his country comes largely from his knowledge of its scenery. He has learnt it. Fidelity to truth in this education has been the habit of his mind, and, not conflicting with moral demands, has brought about a ruggedness of character that has frequently found its illustration during national crises. Here, then, we have a contrast in the effect of art upon mind; and, curiously enough, an apt illustration by way of test was supplied during the Indian mutiny. At the foot of one of the wild craigs of Scotland lies the little village of Ellachie, from which the rugged rock takes its name. Here, during many generations, a few simple peasant families have been found in the peaceful enjoyment of Highland solitude. The tinkling bells of the sheep upon the mountains, the simple airs sung by the Scotch lassies at their work, and the shepherd's bagpipe, supply music that fittingly illustrates the reign of peace in that little valley. But a day came when some of those peasant sons had to leave their quiet homes at the foot of that wild rock and serve in India. There they had not to wait long before they were called to action. It fell to their regiment to sustain one of the most severe onslaughts made upon the British during the whole of the mutiny. The numbers were cruelly unequal, and both English and Scotch were falling fast. At length the Scotch regiment suffered the most severe strain of the contest. Over and over again did these brave Highlanders advance, and as many times they were driven back. Their number was rapidly growing less, and they were at the point of despair. Must they however yield without a final struggle? Memories of old Scotland now quickly returned,—the peaceful Highland homes and absent faces, the wives and little bairnies left behind, the mountain-streams and bleating sheep and the great over-hanging rock protecting all. Should they never see them again? They are seen to halt, and with a tremendous shout which is taken up all along the line, "Stand fast, Craigiellachie!" they charge with such deadly effect that the Sepoys, falling back, are unable to recover their positions, and victory that day is with the British.

I have referred to Mr. Ruskin's view of true inspiration in art, simply to afford a fitting illustration of the difference between interest and inspiration in science—the one being but science at second-hand—honesty in scientific pursuits, however, being its own inspiration. This kind of honesty is no mental evolution, but is practical, and is governed by principle. A man may know all about Faraday's work, but until he can do even one of the things accomplished by that great man, let him not take the name of scientist. But let me not be misunderstood here. I have been speaking of those who mistake the study of results of scientific research for true science, which is a study of a very different kind. It is not required that a scientist should necessarily be a demonstrator. He may not have the means at his disposal for confirming his conclusions. For instance, Mr. R. A. Proctor (who, perhaps, has been the originator of more real scientific work amongst amateurs than any man in this country) is not a practical optician, but, having studied the principles governing the refraction of controlled light in its passage through a series of prisms, one day threw out the hint to Mr. John Browning, that, under certain conditions of intensity, it was possible to obtain a spectrum of highly refracted light by the reversal of the rays through a double battery of prisms, if such battery were constructed upon a given plan. His own words will give the sequence :—" It is rather a singular circumstance, perhaps, in the history of this S-shaped battery, that when I designed it I had never even seen a spectroscope, showing that it is not absolutely necessary to have handled and used a scientific instrument to be able to devise a practical extension of its powers. Mr. Browning made a battery on this design, and Mr. W. Spottiswoode, who purchased the instrument, lent it to Mr. Huggins. It so chanced, by another somewhat singular coincidence, that I saw the solar spectrum (at least, a well-dispersed spectrum) for the first time with this very instrument." We thus see that science requires not merely an active memory, but, with it, a thorough understanding of principles. The demand upon the mental faculties increases with the amount of matter that has to be submitted to them ; and the variety of such, calls for soundness of judgment and absence of prejudice. This has been recognised by all who have distinguished themselves in scientific investigation, but in some cases to such a manifest extent, as to lead to the belief that at one time or another they must have perverted their faculties, and said, "We are prepared unconditionally to surrender our intellects to the governance of their own interpretations of whatever may demand their exercise."

By way of confirmation, I shall mention but one or two cases; yet these are of sufficient importance to bring us to some seriousness upon this point, and to suggest questions to which I think it will be our wisdom to provide distinct replies. We have, then, first of all, the habit of mind evinced by a declaration of one whose researches are connected with the study of germ-life. Mr. Huxley,—to whose labours in this direction the world owes much of its information respecting life in its least complex form,—seems so thoroughly to have surrendered himself to the interpretations he has honestly felt obliged to place upon the protoplasmic phenomena presented to his view, that he commits himself to a statement, which I some time ago remember to have seen quoted (without approval) by Dr. Lionel Beale in his work on Bioplasm, and which I give, as nearly as memory will allow, in Mr. Huxley's own terms. He says:—"The tendency of modern thought lies in the direction of the belief, that the time is not far distant when, in the chemist's laboratory, under favourable conditions, the transition from the inorganic to the organic will be successfully effected." I simply leave this statement with you, asking you to note the extreme caution used in the employment of terms which do nothing more than announce an astounding assumption based upon a conjecture. But we have another example of self-surrender in this matter of fidelity to intellect, and that of so recent publication as to invest it with some interest. The *Pall Mall Gazette* of 23rd September last contains a reply of the late Dr. Darwin to a letter addressed to him by a young German student, in whom the study of Darwin's books had raised religious doubts. He was in intellectual bondage, and asked of Dr. Darwin a way of escape. The following was his reply:—"Sir,—I am very busy, and am an old man in delicate health, and have not time to answer your questions fully, even assuming that they are capable of being answered at all. Science and Christ have nothing to do with each other, except in as far as the habit of scientific investigation makes a man cautious about accepting any proofs. As far as I am concerned, I do not believe that any revelation has ever been made. With regard to a future life, every one must draw his own conclusions from vague and contradictory probabilities.—Wishing you well, I remain, your obedient servant, CHARLES DARWIN." Assuredly this is chilly, but it is the latitude of the north wind that determines its product. *That* is a certitude which lies without the bound of "vague and contradictory probabilities." Expose the intellect to the north wind of scientific inquiry,—let it blow through it with all its strength; but let that intellect first know its own latitude, for snow is never begotten in the tropics. Here, then, we have the conclusions of two of the foremost men of science, and both are negative assertions.

Now, let us not hesitate to face the questions to which that method of procedure in scientific investigation brings us. 1st, Does the material universe enjoy a perfection of self-consciousness; is it self-interpretive? If so, lack of scientific knowledge, and certainly dissension amongst scientists, can find no part in it. If not, some of the most dogmatic assertions of scientists may arise from ignorance. It cannot be otherwise. 2nd, Has the material universe come into existence by spontaneity of generative force, or in other words, did the existent call itself into being when as yet it was not? I do not place this before you to mock your intelligence, but simply because it has been a subtlety, however illogical, that has mastered many minds, and to which Professor Tyndall has felt it worth his while to pay sufficient experimental attention to bring about some settlement. The unaccountable production of mites in cheese, various forms of life in putrid meat, and other forms in decaying vegetable matters, have gone very far to strengthen popular faith in this theory of spontaneous generation. Tyndall's question was, "Does putrid meat spontaneously generate living forms, or do they come to it from without?" To determine this, he, in hot weather, took two pieces of meat and placed them out of doors. The first was exposed to the atmosphere and unprotected. In a short time it was full of animal life. The second was placed in a receiver and the air exhausted, but allowed to re-enter through a thickness of cotton-wool, the meat thus being in an atmosphere that had been previously filtered. After several days' exposure it remained quite fresh, but the cotton-wool was examined under a microscope and found to contain germ-life in abundance. Here, then, was a satisfactory proof that supposed spontaneous generation of life in meat was not such, but simply that the meat was the kind of food best suited to the development of a certain class of living germs in constant atmospheric suspension. Such, I think, is also a fair test-proof with which to supply a negative answer to our question. 3rd, Is matter eternally self-existent? This question implies an alternative possibility, and by it is now made this important demand upon our powers of determination, that if those powers feel themselves unable at once to provide an affirmative reply they had better take refuge in one of the only two propositions left them,—viz., that physical creation either has, or has not, taken place,—and from it build a conclusive proof. Such is the position that Dr. W. B. Carpenter has felt himself obliged to assume in considering this question, and, finding his intellect take a decided direction, at once describes his own work as "the interpretation of the phenomena of nature from the stand-point of causation." In an address upon this subject delivered by him last May, and reported in the *Modern Review* for October, 1882, he traces the scientific conception of causation through its successive stages. First, unconditional antecedence as a cause; next, the notion of force termed "efficient cause." Then John Stuart Mill's perception that a change always implies a power to produce it, and conditions accompanying its production. Subsequent to that, the general admission that heat, light, electricity, magnetism, chemical affinity, and vital agency, are only varied expressions of different kinds of movement amongst the particles of matter. Next, that there was uniformity in the action of these forces, which introduced the term "laws." Up to this point there is no explanation of these uniformities or properties, or this "potency of matter;" but should any explanation of the constitution of the universe by such properties be attempted, Dr. Carpenter shows that one is at once landed in the conception of a very limited number of groups of atoms, distinguished by their attributes,—the heat group, the light group, the electricity group, and so on,—each group, however, consisting of an almost infinite number of individual atoms exactly resembling one another in their properties, "and," says the Doctor, "this similarity could not have originated, except from a common principle independent of them, which destroys the idea of an *eternal, self-existent matter*, by giving to each of its atoms the essential characters at once of a *manufactured article* and a *subordinate agent*." He then states with such clearness the terms of his apprehension of the transition from the physical to the moral causation of nature, that their quotation will at once suggest our fourth question. "The physiologist," he says, "is forced by daily experience to recognise the mutual convertibility of physical and moral agency; the pricking of our skin with a pin producing a change in our state of feeling; and a mental determination calling a muscle, or set of muscles, into a contraction which generates mechanical power. And thus a bridge of connection is established between physical and moral causation which enables us to pass without any sense of interruption or inconsistency from the scientific to the theological interpretation of nature."

Our fourth question, then, is "Has the material universe been created, and is it now sustained and governed, by a first cause?" Now, I am not going to enter upon any argument of a theological character upon this point. I do not forget also that the subject of this paper is "The Conduct of Scientific Inquiry." On the contrary, the closing point I am most anxious to try to establish is that the object which claims first attention in scientific inquiry is, that to which generally very little is paid. I might proceed on the lines laid down by Beale, Stokes, or Carpenter for the theological interpretation of physical causation, but prefer not. Let us give only a strictly intellectual consideration to the matter. It will stand the test. I ask, then, whether it is a scientific method of procedure, when a man employs his intellect as the instrument with which he carries on his investigation in natural phenomena, never to have made it previously turn in upon itself, that it may know what is its natural attitude (*i.e.*, the bent given by early training) towards the object of its inquiry—and not to demand of itself proof of its own power to correctly interpret results? A true scientist should, surely, first of all, submit his mental faculties to a scientific examination of those powers that are absolutely indispensable to his work. Error in the method of their use must lead to error in their deductions. It ought also to be a settled thing with him to what he attributes the existence of those powers.

A celebrated American has said, that scientific thought is the only kind of thought that is not based upon feeling. What I say, then, is that it is imperative that every man should definitely determine his intellectual starting-point ; and my object is briefly to try to show that the intellect need not launch into scientific research, as some compassless barque upon a heaving and restless sea, but that it is able to discover to itself the range of its responsibility, within the boundary line that separates the alone apprehensible from that which may be comprehended,—and to do so never more surely than when in contemplation of its work. Let us first be severe in our treatment of ourselves, and make up our minds to throw, or be thrown, upon the strictly intellectual ground. We need not fear being landed in any fog ; if we do, we must alter our definition of the phrase, " scientific research." Conscious liability to fog must always engender subtle suspicion of the correctness of such of our conclusions as may suggest the question, " Why ? " An honest intellect, then, must proceed on one of two assurances, either that there has, or has not, been a first cause, and that there is, or is not, a sustaining and governing agent. The only other course open, is to take refuge in the view that our intelligence is limited, and can never of itself come to a decision upon this point. Darwin's letter shows that he resorted to this course. He is almost dogmatic in the matter of intellectual limit.

Now, before referring to the alternative question, let me submit two or three propositions to show that such a position as this last is untenable. It supplies the material for its own overthrow. What is a limit ? An imposition. A limit is therefore a creature. A creature pre-supposes a creator, for a creature and its creator cannot be one and the same existence, until a thing can be, and cannot be, in the same sense, and at one and the same moment of time. A creator, then, is in the nature of things distinct from its creation. But the first limit was a creature. Its creator, therefore, is illimitable,—and that, at least, in the attributes of *power* and *duration*, called into exercise in the creative act.

The question now remains, " Does the intellectual method lead us to the straightforward assertion that there has been no first cause, nor a sustaining and governing agent,—in other words, that there has not been, neither is, a God ? " Without referring to the previous simple propositions, or going further than to suggest the illogical condition of the mind that will remain content to entertain the idea of dependence independent of independence, let me bring before you the views of John Foster (Essays, 15th Edition, p. 35) respecting it:—"The wonder then turns," says the author of the Essays, "on the great process by which a man could grow to the immense intelligence which can know that there is no God. What ages and what lights are requisite for this attainment! This intelligence involves the very attributes of Divinity, while a God is denied. For unless this man is omnipresent, unless he is at this moment in every place in the universe, he cannot know but that there may be in some place, manifestations of a Deity, by which even he would be overpowered. If he does not know absolutely every agent in the universe, the one that he does not know may be God. If he is not himself the chief agent in the universe, and does not know what is so, that which is so may be God. If he is not in absolute possession of all the propositions that constitute universal truth, the one which he wants, may be, that there is a God. If he cannot with certainty assign the cause of all that he perceives to exist, that cause may be God. If he does not know everything that has been done in the immeasurable ages that are past, some things may have been done by a God. Thus, unless he knows all things,—but that precludes all other Divine existence by being Deity himself,—he cannot know that the Being whose existence he rejects does not exist. But he must *know* that He does not exist, else he deserves equal contempt and compassion for the temerity with which he firmly avows his rejection and acts accordingly."

Thus does Foster use the negative method by which to beset the position with very grave difficulties, and I trust the consideration of the following quotation will be quite conclusive. It is from the introductory address of that great explorer in the paths of physical science, M. Pasteur, on his entrance last April to the French Academy. He employs the positive method of placing the case, and in his peroration says:—"The great, the obvious deficiency of the Comtist system is, that in its positivist conception of the world it discards the most important of all positive notions—that of the Infinite. Beyond the starry vault above us, what is there? Other starry skies. Well, and what beyond those? The human mind, swayed by an invincible impulse, will never cease to inquire what there is beyond, and there is no point, in time or space, which can set at rest the implacable question. It is no use to reply that beyond any given point there are boundless space, time, or magnitude. Such words convey no tangible meaning to the human mind. The man who proclaims the existence of the Infinite (and there is no man who does not) accumulates in that bare statement more supernatural elements than are to be found in the miracles recorded in all religions; for the notion of the Infinite has this double character,—that it is at once self-evident, that it forces itself upon the mind, and yet is incomprehensible. When that notion masters our mind, nothing is left for us but to bow down and kneel, and at that moment of poignant anguish, a man must crave mercy from his reason."

I have endeavoured in this paper to survey, somewhat practically, the subject of "Scientific Inquiry" in that aspect of it which concerns the intellect, and have done so because I am convinced that there is growing up with many of those who are beginning to apply themselves to scientific pursuits, an ill-regulated condition of mind respecting things universally regarded as of first importance, which, if not apprehended, may in time lead to a pronounced dogmatism that will handicap all research. A few principles, or as many proved facts of science, are often, now-a-days, all the provision made by such persons with which to weigh each question that can arise, in any way touching the origin of physical creation.

I have previously remarked, that merely natural inclination towards scientific pursuits will become most disastrous in its effects, where such inclination takes the form of piracy rather than of honest research. Give me a lad that will watch for half-an-hour the movements of a common House-fly, and then go and use his thoughts, and I hold him up as a pattern to such as are simply "constant readers" of our Scientific Notices. Keen observation is the only condition of ability to grapple with questions in which the principles of physical, mental, and moral science are involved, and this observation must be honest. A subtlety has laid hold of many of the younger members of our Scientific Societies, of which they seem to be unaware, and which is leading them, practically, to relegate to the region of the unprovable, even facts that can be ascertained concerning the mind's ability to provide itself with certain scientific tests of truth; facts that must be taken into account if research is to be invested with value. For instance, those persons will stoutly defend their intuitive convictions of the existence of time and space, yet cannot account for their possession of those intuitions; they are obliged to admit that such form part of a plan upon which the human soul has been constructed; and yet, whilst making this admission, they are seriously calling into question proofs of the existence of a planning mind. In truth, it is beyond the province of Nature, when studied in this way, to produce order from such a mentally nebulous condition. If they would but form the habit of balancing over against the mysteries presented to them in natural phenomena, some facts which they are well able to discover for themselves, concerning the limits of the human mind, I think they would oftener be more ready than they are to see that there are conditions of things beyond the acknowledged power of man's mind to understand,—conditions which are marks of an intelligence higher than their own. Well may we all ask with Young:—

> "Who, motion, foreign to the smallest grain,
> Shot through vast masses of enormous weight?
> Who bade brute matter's restive lump assume
> Such various forms, and gave it wings to fly?
> Has matter innate motion? Then, each atom,
> Asserting its indisputable right
> To dance, would form a universe of dust:
> Has matter none? Then, whence these glorious forms
> And boundless flights, from shapeless, and reposed?
> Has matter more than motion? Has it thought,
> Judgment, and genius? Is it deeply learn'd
> In mathematics? Has it framed such laws,
> Which, but to guess, a Newton made immortal?—
> If so, how each sage atom laughs at me,
> Who think a clod inferior to man!
> If art, to form; and counsel, to conduct;
> And that with greater far than human skill;

Resides not in each block;—a Godhead reigns."

*　　*　　*　　*　　*　　*　　*

"And, if a God there is, that God how great!
How great that Power, whose providential care
Through all these bright orbs' dark centres darts a ray!
Of nature universal threads the whole!
And hangs creation like a precious gem,
Though little, on the foot-stool of His throne."

Notes on the Exhibition of Magnified Objects.

By Carey P. Coombs, M.D.

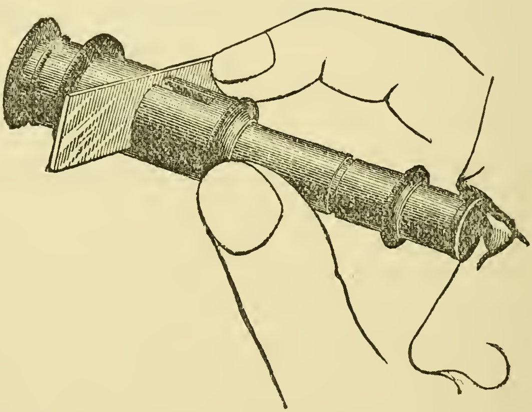
I SUPPOSE that there are few workers with the microscope who do not desire to show to others what they see themselves. And this is not easy to accomplish when there are many to whom an object is to be shown. If there are a number of observers and many slides, several instruments and demonstrators must be procured; and there are points of detail in the management of such a demonstration, which can only be learned by experience, Let it be clearly understood that I state what I have done, to elicit from other members of the "Postal Microscopical Society" and readers of this Journal their practice in similar cases.

On those occasions on which I have shown many objects to a meeting, I have used three or four microscopes on as many tables, with a collection of mounted objects suitable for the power of the object-glass borne by each instrument. For instance, to a micro scope with a quarter-inch, a selection of diatoms, plant-crystals, and cuticles are apportioned. The microscope bearing the half-inch is fitted with the polariscope, and objects which will be best seen with the aid of this accessory, are placed on its table.

In examining the slides sent in our boxes, I have often noticed the large proportion of those for which the half-inch objective answers best. Lower powers are most serviceable if there are other stands—the inch for small insects. Everyone knows how welcome the parasites (under the microscope) are; also for double-stained plant-sections, hairs, scales, and for rock-sections. The beauties of mosses, algæ, etc., are best shown with the two-inch.

Demonstrating or class microscopes are most valuable in lectures on natural sciences, but their use must be generally restricted to professional teaching. I have seen them used by Dr. Beale many years ago at the College of Physicians, when he was demonstrating his "Germinal" and "Formed" matter. Instruments like his are now made by Messrs. Salt and Son, of Birmingham, a drawing of which is annexed. Those made by Parkes and Son, of Birmingham, were represented in Part 1 of this Journal.

Fig. 1.



But if an object is to be shown and explained to a number of persons at the same time, it is evident that some method of projection must be employed. I find that men of much experience in matters of this kind think that it is best to get a picture of the object, and project that upon a screen.

In Part 2 of this Journal, Mr. H. Barker gave a very clear account of the processes for photographing magnified objects; but in order to obtain good negatives, much practice and skill are required, and the printing of transparencies is a further difficulty; manufacturing opticians are now offering a great variety of such slides. Drawings on glass roughened by emery, or a thin layer of photographic varnish, are sometimes used instead of the photo-micrographs above mentioned. I have seen pictures drawn by Mr. Dallinger, showing well on a disc about 15 feet in diameter, or in other words magnified 60 times—a pretty good test of the fineness of his lines. These pictures can be clearly projected on a ten-feet disc when using the paraffine-lamp with three wicks, which is employed in the lanterns known as the Euphaneron, the Lucidus, and others.

Some objects may be directly projected on a disc not exceeding two or three feet in diameter, with such a light as this, but good work of the kind can only be done with the best form of lime-light. At present, the production of a steady electric arc involves so much trouble and expense, that it is out of the question.

By the best form of lime-light, I mean that both gases must be under considerable and equal pressure, the oxygen well washed twice, and the lime so placed that the gas-jet gives no shadow. But, even then, a professional lecturer said to me, "If you are inclined for a great deal of trouble and expense, and very small results, obtain an oxy-hydrogen microscope." I am not the possessor of such an apparatus, but I have been collecting all the information I could obtain on the subject for some years.

It is usual to make lime-light lanterns of wood, and that should be the case with an apparatus for projecting images of objects. The condenser should be four inches in diameter. The best kind will produce a circle of rays focussing at about 8 inches. The object-holder and objective mount—which is racked—should be in one piece, and capable of being moved backwards and forwards in the tube which carries them. The purpose of this is that the object may be placed at the point of greatest light. This point is also a very hot place, and balsam-mounted objects soon suffer; but much of the heat may be cut off by a trough filled with a solution of alum, placed in the usual lantern-stage. Ordinary microscopic objectives of a-quarter and half-inch focus are considered best; but when the objects are large, special lenses of large actual aperture and long focus are required.

The best surface on which to project the picture is a smooth wall or screen coated with white enamel; transparent screens do not give so good results. It is hardly necessary to give a list of the slides best suited for this mode of exhibition; they will be selected by any microscopist who keeps in mind the conditions.

In conclusion, let me repeat my hope that my paper will induce other members and readers to offer information on this subject.

The Microscope in Medicine.

By J. B. Jeaffreson, M.R.C.S. Lond., L.S.A., &c.*

IN this present utilitarian age, nothing is thought much of unless it can prove its usefulness, and I believe many would feel more interest in microscopic work if they realised the fact that the microscope is not only a scientific toy, but that it is actually of great use in the elucidation of truths which promote the interests and welfare of mankind. I thought, therefore, it might be interesting if I attempted to show some of the uses of the microscope in medicine—how it assists us medical men in our battle with many of the ills of life to which our human flesh is heir. My only difficulty is the vastness of the subject I have chosen, and the impossibility of compressing into a single paper what would rather occupy a long course of lectures.

The subject naturally divides itself into the three following branches of medical study:—first, the uses of the microscope in Physiology, or the study of the science of life in health; secondly, in Pathology, or the study of the different organs and tissues in disease; and thirdly, in Practice, as it is useful to us medical men in our daily treatment of disease.

It will be readily understood that disorders cannot be properly studied in the absence of the knowledge of the means by which healthy action is carried on, so that before commencing

* Read at a meeting of the Highbury Microscopical and Scientific Society, June 23rd, 1881.

the study of illness, it is necessary for us to understand the minute anatomy of every organ and the mechanism by which the various physiological actions are performed in health.

Now, careful dissection will reveal to us much of the structure of the body as far as it can be seen by the unaided eye, but beyond that limit it is impossible to carry our investigation without the aid of the microscope, while by it, in every part of the organism, we are now able to trace structures which were before unknown. Take, for instance, the arrangements for the circulation of the blood. Harvey had shown that the blood, distributed by the left side of the heart through the general arteries of the body, returned through the veins to the right side, and thence, after passing through the lungs, again reached the left side; but how the blood passed from the minutest arteries to the earliest veins, the older physiologists were not a little puzzled to understand. They traced these vessels as far as they could see them, and when they could no longer do so, they supposed they must have terminated in small, open mouths, by means of which the blood was emptied into the tissues, which then helped themselves to what they wanted, and passed on the remainder into the open mouths of the minutest veins, for it to be returned to the heart.

But now, with the help of the microscope, we can follow the whole course of the circulation in the web of the frog's foot, and see that the smallest arteries lose themselves in a network of fine vessels called Capillaries, out of which, as out of so many roots, a small vein gathers itself together again. These small vessels are seen to be minute channels of uniform size, their average diameter being about one-three-thousandth of an inch, composed of extremely fine, transparent walls, and spread over every part of the body, and that so closely, that it is impossible to prick oneself in any part without rupturing some of them. These minute vessels carry to every organ the nutritive fluid without which life and growth could not be supported, and they also carry the blood to various organs, in which it is purified and regenerated, and made fit for supporting the vital functions, their manner of distribution being modified according to the requirements of each part.

Thus, in the lungs, we see by the microscope, that the ultimate divisions of the bronchial tubes, which convey the air into the lungs, end in elongated dilatations, about one-fortieth of an inch in diameter, each of which is made up of numerous little cells or sacs opening into the cavity of the dilatation—which are called air-cells—and the very thin walls of these air-cells carry the wide, thin-walled, and closely-set capillaries, into which the ultimate divisions of the pulmonary arteries pour their blood, so that the blood is exposed on both sides to the air, being separated only by the delicate pellicle which forms the wall of the capillary and the lining of the air-sac; and while this exposure is going on, the blood parts with its carbonic acid and absorbs fresh oxygen for the proper support of the vital functions.

Again, in the liver, we find that the portal vein, which conveys the blood from the abdominal viscera, breaks up into minute branches, which map out the whole liver into small oval divisions or lobules, and from these branches proceed on every side minute capillaries, filling up nearly the whole substance of the liver, and finally joining a vein, which with outspread branches occupies the centre of each lobule, and carries off the blood from the liver, after the secretion of bile has been effected by means of the hepatic or bile-cells, which fill up all the interspaces between the before-named capillaries, and which discharge their contents into the minute bile-ducts, which lie in the spaces between the lobules; while in the kidneys the vessels which supply these organs, form little vascular tufts or balls—called malpighian corpuscles—each of which lies in a little flask-shaped sac or capsule, proceeding from the walls of certain small tubules, which lie in the substance of the kidney, and which are lined with nucleated gland-cells, by means of which the separation of the urine from the blood is effected.

The microscope has also revealed to us the wonderful provision for regulating the supply of blood to each part. Every artery—even the smallest—is seen to be encircled by numerous muscular fibres, which have the power of contracting the size of the vessel, and thus diminishing the quantity of blood passing through it. And these muscular coats are seen to be supplied with numerous fine nerve-fibres, by which the degree of contraction is determined.

Having glanced at the circulatory apparatus, we will now see what the microscope has taught us about the nutritive fluid, the blood. We find that, instead of being—as it appears to the naked eye—a red fluid, quite clear and homogeneous, in reality it consists of a nearly colourless fluid, in which are suspended numerous cells, or corpuscles, of two kinds. Some are circular, flattened discs—about 1-3200th of an inch in diameter and about one-fourth of that thickness, having a yellowish red tinge, the aggregation of which gives the red colour to the blood. The other kind of cells are colourless, larger, and much less numerous than the red ones, having a diameter of about 1-2500th of an inch, and differing from them by the irregularity of their form, and also by the fact that they have a curious trick of constantly changing their shape. If we carefully watch one under the microscope, with a magnifying power of five or six hundred diameters, we see that every part of the surface is constantly changing, undergoing active contraction, or being passively diluted by the contraction of other parts. This power of independent contractility is similar to what we see taking place in those simplest organisms which are met with in stagnant water, and are called *Amœbæ*, and this movement has therefore been called the *Amœboid* movement of the white cells.

In a similar manner, by the same instrument, we have learned the minute structure of the brain, the general distribution of nerve-fibres to every organ, the minute structure of muscular fibre, the structure of various glands, the marvellous adaptation of the skin as a covering to the body, with its hairs, perspiration-glands, and other appendages.

But we must leave this first part of our subject, and proceed to look at some of the teachings of the microscope in Pathology.

As in Physiology, it has taught us the minute structure of every tissue of the body in health; so from it we learn the structural alterations which take place in disease, and from these alterations we try to discover the causes of the morbid action and to find out the means by which they can be removed.

Thus, by means of it we can watch the very changes going on in the blood-vessels during the process of inflammation. Putting a few grains of mustard on the web of a frog's foot, we see, in the first place, that the muscular fibres of the smaller arteries yield and become flaccid and elongated, and, in consequence of this, the diameter of their tube is increased. A greater quantity of blood, therefore, flows into the capillaries, which become distended, and the movement of the blood gets slower and slower, and at last completely stops; and if this continues long, it would result in serious structural changes of the inflamed part. But if at this stage the mustard be removed and the web kept moist, it will be found that the movement of the blood re-commences, and the normal condition is re-established, and the part resumes its natural state.

One of the most important results of microscopical research has been the development of the *germ theory* of infectious diseases, by which theory it is supposed that the epidemic diseases are due to minute parasitic germs, which float in the atmosphere, enter the body, and by their growth and development produce various febrile disturbances of more or less gravity, the communication of which germs from one individual to another constitutes infection. It is true that, at present, the actual germs, the development of which cause the various infectious diseases to which man is subject, have not been microscopically demonstrated, although certain German microscopists suppose that they have found the germs of cholera and measles; but disease-germs have been plainly traced in some of the diseases to which the lower animals are subject. The first step in this branch of study was the simultaneous discovery by Cagniard de la Tour and Schwann of Berlin in 1836 of the yeast-plant, a living organism, which, when placed in a proper medium, feeds, grows, and reproduces itself, and in this way carries on the process which we call fermentation. Some years subsequently, the great Pasteur discovered that a mysterious disease, which affected the silkworms in the valley of the Rhone, was caused by a living parasite, which consisted of vibratory corpuscles, which took possession of the intestinal canal, and more or less completely occupied the whole organism of the worm. Judging by analogy, he came to the conclusion that many of the zymotic diseases are caused by these lower fungi, especially *Bacteria*, and since then further investigation and improved microscopic research have discovered the special form of germ which gives rise to many forms of disease.

More recently, Pasteur has been carrying out a series of experiments on the cholera of fowls, a disease virulent in the highest degree, but which has the characteristic common to many epidemic diseases, that one attack has the power of more or less protecting the sufferer from subsequent infection. He has discovered that the poison in this disease is a microscopic parasite, which can be cultivated outside the animal by being introduced into a suitable decoction, and also that, by making successive cultures at prolonged intervals, he can reduce the virulence of the virus, so that ultimately a poison is produced which will give the disease in a mild form, but which, as vaccination is a protection against small-pox, renders the fowl insusceptible to the severe form of the disease.

It has also been shown that another disease—Anthrax or Splenic fever, a disease to which animals are subject, and which is specially interesting from the fact that it gives rise to a serious and fatal disease in man known as "*wool-sorter's*" disease—is produced in animals which have fed upon fodder containing germs of a Bacteria—*Bacillus anthracis*—and Dr. Greenfield has proved that these germs also become progressively less virulent in successive generations of artificial cultivation; and he has thus obtained a modified virus, producing more or less severe symptoms, and appearing to be partially protective against future severe attacks. These experiments seem to open out the possibility of reducing the virulence of the disease-germs of scarlatina, measles, etc., so that a mild form can be given which will act as a protection against the severer forms. Should this prove to be practicable, the youth of the future will not only have to suffer vaccination for small-pox, but will also have to undergo a mild course of scarlatina, measles, typhus, typhoid, cholera, diphtheria, whooping-cough, and all other germ-caused diseases. Under these circumstances, I think it may be questionable how far the earlier years of the life of future generations will be worth living.

In addition to these minute vegetable-parasites, we are also at times called upon to play the part of host to various kinds of animal-parasites, all of which take up their abode in some parts of our organism, inflicting upon us more or less serious and sometimes fatal disorders, and many peculiarities of the life of these gentlemen have been revealed to us by the microscope.

No doubt, most people have heard of certain unpleasant organisms, called tape-worms, which are in the habit of taking up their residence in the intestinal canal, and which, if they once settle down on their estates, are as difficult to dislodge as an Irish tenant-farmer. The microscope has revealed the following peculiarities in the life of these uncomfortable guests :—The ordinary Human Tapeworm* consists of a head provided with a ring of four suckers, by which it attaches itself to the mucous membrane of the intestines, and then proceeds to develope a number of joints, each of which contains innumerable eggs, the whole creature being sometimes 20 or more feet in length. There may be as many as 1,200 joints, and each joint may contain 30,000 eggs. Each of these microscopic ova is covered with a little leathery capsule containing a minute embryo in its interior, and if one of these little ova be swallowed by a warm-blooded animal (in this case the cow) the embryo is set free, and soon bores its way through the walls of the stomach of its new host by means of little siliceous hooks. Having reached a suitable locality, it surrounds itself with a cyst, and developes from its hinder end a kind of bladder, and is now a *Cysticercus*, or Bladder-worm, embedded in the muscles, and constituting the diseases known in animals as *measles*. In this state, it may remain for an apparently indefinite time, being incapable of producing eggs; but if a piece of measly beef (not sufficiently cooked to destroy the life of the *Cysticercus*) is eaten, the bladder-like part is digested, the young tape-worm is liberated from its cyst, and attaches itself by its suckers to the mucous membrane of its new host, and from its end developes a new tape-worm.

Different forms of tape-worm select different animals for their hosts, Thus another, which infests man in its adult state, shows a preference for *pork* in infancy, and in its cystic form is developed in the pig. The tape-worm of the cat is the adult bladder-worm

* *Tænia mediocanellata*, according to Cobbold, is the most common in man, and passes its immature state in the ox.

of mice; that of the fox is derived from the cystic worm of hares and rabbits.*

Another very serious disease—chiefly occurring in the liver—is characterized by the development of large cysts or bladders, the large parent cyst often containing numerous smaller cysts. For a long time, the nature of these hydated tumours was unknown; but by microscopic investigation they have been proved to be the development in man of the ova of the *Tænia echinococcus*, a very small tape-worm, which inhabits the intestinal canal of the genus *Canis*. Here the process which takes place in the human tape-worm is reversed, the ova of the tape-worm of the dog developing into the cystic worm which causes hydated disease in man.

Equally dangerous is the nematode worm, *Trichina spiralis*, which, although the adult male is only one-eighteenth of an inch in length, and the female one-eighth of an inch, has contrived lately to create quite a scare among the consumers of pork, hams, and sausages. The larva of this interesting creature spends its immature stage encysted in some such animal as the pig, but when introduced into the stomach of some other warm-blooded animal—as man—is capable of producing an immense number of little *Trichinæ*, which swarm out of the parent by tens of thousands, and bore their way in every direction, stopping at nothing except bone, and finally settling down among the voluntary muscles, where they proceed to make themselves comfortable. During these wanderings, they give rise to a train of symptoms which somewhat resemble acute rheumatism, and is not unfrequently fatal. Should this not be the case, they sooner or later lose their vitality, and become converted into little particles of lime, and thus a natural cure is effected. Their numbers are so enormous that an unfortunate foreigner who died from an accident in the London Hospital, and was found full of *Trichinæ*, was calculated to be acting the part of host to some hundred millions. Without the microscope, it would have been impossible to have discovered the cause of this disease.

An epidemic of Trichinosis occurred at the village of Khian,

* The head of the Beef Tape-worm has a row of suckers, but no hooklets. The head of the Pork Tape-worm has hooklets as well as suckers.

near Beyrout, at the close of the year 1880, some particulars of which may be of interest. A wild boar was shot on the 25th of November, and, as the poor people in these parts have not much opportunity of getting animal food, it was distributed as a luxury all round the neighbourhood. Of those who partook of the flesh, 257 persons were more or less affected, and of these six people and two cats died. The following description of the symptoms is given by a physician at Beyrout, who investigated the outbreak. He says :—" From ten to twenty days after eating the meat, the face and extremities became œdematous, the swelling extending over the whole body. This was accompanied by severe pain in all the muscles, with more or less fever. These phenomena did not continue more than two or three weeks, and were followed by slow convalesence, with much weakness and lingering muscular pains."

Another disease—not dangerous, but very unpleasant—the Itch, is shown by the microscope to be caused by a parasitic insect, the *Acarus scabiei*, which burrows in the skin, setting up severe and troublesome irritation.

Several skin affections have been found to depend on the development of microscopic fungi in the epidermis, and the troublesome complaint, Ringworm, is known to be caused by the growth of the *Trichophyton tonsurans.* It is found in the form of very minute oval, or rounded and perfectly transparent cells, within the bulb and in the central canal of the hair, by the rapid increase of which the fibres of the hair are split up and become quite dry and brittle.

Among other diseases whose morbid anatomy has been illustrated by the microscope, we may mention Gout. It depends upon the presence of an excess of uric acid in the system, which is deposited in the joints, and by making a thin section of a gouty joint, and examining it with a ¼-inch objective, we may see fine interlacing crystalline needles or prisms of urate of soda, which project into the substance of the healthy cartilage, and which become more highly illuminated, and more or less coloured if we examine them with the polariscope.

Having now seen some of the uses of the microscope in Physiology and Morbid Anatomy, we must in the last place look at some of its uses to us in our daily practice. One of the most frequent and important uses in practice is the examination of deposits in the urine. The presence of blood-cells shows that hæmorrhage is going on in some parts of the urinary apparatus, while pus-cells show that suppuration is going on, or that an abscess has burst into the bladder or kidneys, and the presence of different crystals in the urine are symptomatic of different constitutional derangements.

The presence of uric acid in the blood may be shown by putting a little of the serum (or fluid part of the blood) in a watch-glass, and adding a few drops of acetic acid. Two or three fine filaments of silk are then placed in the mixture and allowed to stand twenty-four hours, when the microscope reveals numerous minute crystals of uric acid attached to the filaments. This, in many instances, would give definite proof of the existence of undeveloped gout in the system, and might often account for various anomalous symptoms.

Itch is demonstrated by finding the *Acarus scabiei* in its burrows in the skin, and Ringworm by the presence of the spores of *Trychophyton tonsurans* in the hair.

The presence of intestinal worms may often be suspected from the symptoms, but by microscopic examination we can detect the ova, and so be certain of their existence, and by examination of a small portion of muscle in a suspected case of Trichinosis we could prove the presence or absence of *Trichinæ.* An interesting use of the microscope occurred during the recent formation of the St. Gothard Tunnel. The workmen were attacked by a small nematode worm--the *Anchylostomum*, which attached itself to the upper part of the intestinal canal by a cup-like sucker, and then proceeded to suck the blood, causing extreme weakness, and in some cases death. When this disease was suspected in any of the workmen, the correctness of the diagnosis was proved by discovering the ova in their fæces.

The expectoration of consumptive patients often contains fragments of lung-tissue, which in some cases may be detected by the microscope before positive signs of the disease can be detected by other means. With reference to this, Dr. Andrew Clarke says, " That the microscopical inspection of expectoration affords, at a very early period of consumption, definite information not otherwise attainable regarding the nature of the malady; and at all times must furnish valuable aid in forming a prognosis regarding the cause of the complaint."

Sometimes we can discover the characters of certain tumours by puncturing them with a fine-grooved needle, and then examining the fluid which exudes from them, and so finding out their constituents. Thus, the hooklets of the *Echinococcus* may be found in the fluid-contents of an hydated cyst.

Very useful has the microscope proved in the detection of crime, poison, and adulterations. Suspected blood-stains have been proved to be such, partly by the presence of blood-cells and partly by the development of blood-crystals, and of late by the characteristic spectrum of the colouring matter of the blood by the spectroscope. The microscope cannot actually distinguish between the blood-cells of man and of other mammals; but it can distinguish between the circular cells of the blood of mammals and the oval cells of birds or reptiles, and this character served to detect an imposture in the case of a woman who pretended to have ruptured a blood-vessel; but on microscopic examination it was proved that the blood was that of a fowl, by the oval cells it contained. The late Frank Buckland, in his "Curiosities of Natural History," mentions a case in which a murder was brought home to a woman who had cut the throat of her little daughter. A few hairs found on a knife were sent to an eminent microscopist. They came back labelled "Hairs of a Squirrel," and it was proved that the poor child, when murdered, had on a boa made of squirrels' fur, some of the hair of which had adhered to the knife, and which thus formed the missing link in the chain of evidence.

In cases of poisoning, we may be helped in distinguishing the characteristic crystalline forms of different salts—as the octohedral crystal of arsenious acid, the tetrahedron of tartar emetic, the six-sided prisms of morphia, and the four-sided prisms of strychnia and oxalic acid. In cases where children have eaten poisonous fruits or berries, we may recognise seeds in the matter vomited; among others, those of *Belladonna*, *Hyoscyamus*, *Digitalis* or Fox-glove, *Stramonium*, the *Papaver somniferum* or Opium, Poppy, etc.

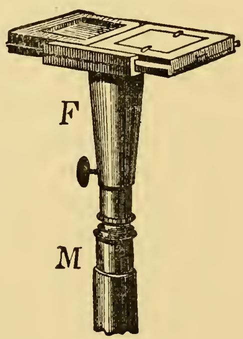
Lastly, our medical officers of health may detect various adulterations in their examination of milk and other articles of food. The adulteration of wheat-flour with potato-starch, or the meal of beans or peas, may be detected by the presence of the different grains of starch belonging to these substances. Alum in bread may be dissolved out in water and then re-crystallised under the microscope, and the presence of chicory and roasted coffee may be detected in adulterated coffee. Among these adulterations, I may just mention an ingenious manufacture, by which some Frenchmen recently prepared jelly from the *Arachnoidiscus Japonicus*, a sea-weed much used to pack up the Chinese and Japanese porcelain, which, being appropriately flavoured and coloured, was palmed off upon the unsuspecting Parisians as the "Finest Fruit-Jelly." But, fortunately, this plant-jelly retained some of the fibrous nature of the plant, and was proved by the microscope to differ *in toto* from the genuine article.

I must conclude. Much more might have been added, but I think my readers will allow that I have succeeded in demonstrating the proposition with which I started, namely—the USEFULNESS OF THE MICROSCOPE IN MEDICINE.

Photo-Micrography.

THROUGH the kindness of the Secretary of the Royal Microscopical Society, we are enabled to give a figure of Stein's photo-micrographic apparatus, which, though small and simple, is said to answer its purpose completely. It consists of a cone, F, which is inserted into the tube, M, of the microscope instead of an eye-piece; a plate of ground-glass is fixed to the top, and on this the image can be focussed, the observer's head being covered with a black cloth. The ground-glass plate is replaced by the prepared sensitive plate, and the image can then be readily photographed.

Fig. 2.



This process, if successful, would certainly involve a much smaller outlay of expense and labour than any other we have yet heard of.

A Method of Making and Mounting Transparent Rock-Sections for Microscopic Slides.

By John Smith.

THE following method of making and mounting transparent Rock-sections for the microscope, was taught me several years ago by the late Mr. Arthur Pratt, of Glasgow. And, with a few exceptions, which will be noted, the method I use is essentially that followed by Mr. Pratt.

The first step is of course to get a suitable piece of rock, say, a fragment of Trap or Basalt.

This should be broken as thin as possible, and to do this, having struck off a fragment from the parent rock, or boulder, take it between the fingers and thumb of the left hand. Hold one edge on the rock from which it was struck, or any hard stone which may be convenient, and strike it a sharp blow with the hammer, *fair* on the opposite edge. If this is well done thin fragments, about one-eighth of an inch thick, will fly off.

These fragments ought to be rough-hewn, on the spot, so long as there is plenty of material to work from, and for this purpose I use a pair of cutting nippers such as are used for cutting wire. With a little practice, any one will soon become expert in using them. Take a thin fragment of the rock in the left hand, and with the nippers work round it, clipping off the superfluous angles until a disc of about seven-eighths of an inch in diameter is formed. With a little experience this can be done in less than a minute. My practice is to take four such discs, of each kind of rock from which I wish to make sections; two to ensure getting a finished section, and two to meet the requirements of friends.

I also take a thin piece of the rock one inch and a quarter square, or thereabouts, as a cabinet specimen, and for comparison with the finished section. This specimen should, if possible, show a weather-worn face, although it is not always possible to get a specimen in this state, especially if it is taken from a mine, or quarry. The specimens ought to be labelled on the spot, and the most convenient way to do this, is to have with you a quantity of elliptical or circular gummed labels, about three-quarters of an inch in diameter. If the specimen is taken from a Trap Dyke, the thickness or width of the Dyke should be taken, and the particular place from which the specimen was struck noted.

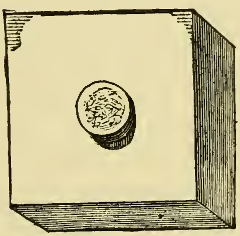
If the Dyke is a *wide* one, two, or possibly three sections will be required to show its structure. For in wide Dykes, specimens taken from the middle will be found to be softer, and the crystals larger, than specimens taken from near the side of the same Dyke. Mining men are well acquainted with this, and I may mention it as a fact, that in cutting a mine six feet high by six feet wide through a sixteen fathom Dyke, in the Ayrshire Coal Fields, it cost twenty pounds sterling per fathom, to cut the mine near the sides of the dyke, whereas near the centre it was driven for six pounds per fathom. It would be out of place here to enter into an argument of the causes.—First, why Trap Dykes exist at all, and second, why they are harder and more finely "grained" at the sides than they are in the interior. I may just say, for the benefit of those who have not studied these matters, it is the accepted theory, that Dykes have at one time been molten rock, filling up cracks in the Earth's crust, and that naturally this molten rock cooled quicker at the sides of the crack than in the centre, and consequently the Dyke is more finely crystallised and compact at the sides, than in the interior.

This, then, I hope, will be a sufficient reason for saying that more sections than one are required to show the Microscopic structure of a *wide* Trap Dyke, or in fact of almost *any* Dyke.

The student who follows these instructions about chipping and cutting, will be able to take home as many specimens in his pocket as he could otherwise do in a large bag, by the old method of simply using the hammer; and this is no small matter, when one walks perhaps twenty or thirty miles, in a day's hunting after specimens.

Having got safely home with a variety of specimens, the next thing to be done is to make the discs roughly circular, and to flatten and polish *one* side. To do this, I use a flat slab of polished sandstone, eighteen inches square by four inches thick, on which I rub the edges of the specimen, using *water*, and giving it a slight turn at every rub; a very little practice will enable anyone to make the discs almost circular. But what is chiefly to be aimed at in making them circular, is to get a *smooth edge*, as a disc having a perfectly smooth edge will not break so readily in the subsequent process, as a rough-edged one. It should now measure about five-eighths of an inch in diameter. The flat face must next be *polished*, so as to remove every trace of scratching caused by the sandstone, and at the same time it is necessary to make this face *perfectly flat*. To accomplish this, I use a Water-of-Ayr hone, seven inches square, by two and a half inches thick, having one of the faces *perfectly* flat. On this face the disc is rubbed with water, until it also becomes perfectly flat and free from scratches. It must then be made *thoroughly clean* and mounted on a piece of *hard wood*, as shown in Fig. 3.

Fig. 3.



I use well-seasoned Beech wood, two inches square by three quarters of an inch thick. Fix the disc to the block of beech with gum arabic, putting plenty of the gum round the sides, so as to form a collar, and allow it to harden for two or three days.

The specimen is now to be ground down, until the beech can be seen distinctly through it. It will not do to rub it on the sandstone now, as water would dissolve the gum, and the specimen would be at once detached. For the purpose of rubbing it down, use a flat metal plate, coarse emery powder, and paraffine, turpentine, or benzoline, as none of these substances will dissolve gum arabic. Mr. Pratt used to rub his specimens down entirely on the metal plate, using finer emery powder as the specimen became thinner. But after it has been reduced to about the twentieth of an inch in thickness, I find I can make more speed by using a Turkish whetstone sprinkled with a little of the finest emery powder, and rubbing on this till the wood may be *dimly* seen through the specimen. At this stage I clean the specimen, wood, and whetstone, with a piece of rag soaked in turpentine, and rub down on the bare stone, using the same fluid, till the specimen is thin enough to be taken off the wood. Of course, this is the most critical period in the rubbing process, and the period at which one is most apt to lose his temper, for if the stone is a hard one, progress is very slow; the rubbing must be done very gently. If the digestion is at all out of sorts, the destruction of the specimen is all but certain, and if a single grain of emery lingers about the whetstone, the thin and transparent section will inevitably be cut in two. Lately, I have fallen on a plan which has proved an almost perfect cure for impatience and ill nature, at this critical stage of the proceedings. It is this:—Keep a dozen specimens advancing one after the other. When you have become tired of one, lay it down and take up another. Strange as this may appear, it is quite a cure for impatience; and besides, more progress may be made with a dozen, than by working with one specimen only at a time.

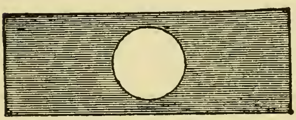
I may say here that in making sections of flints, agates, and stones of like hardness, it is of no use rubbing them on the sandstone; they must be ground down from the very first on the iron plates with emery. The rest of the process is the same as has been described above.

I fancy that diamond-dust would be the disintegrator *par excellence*, but have never indulged in this luxury.

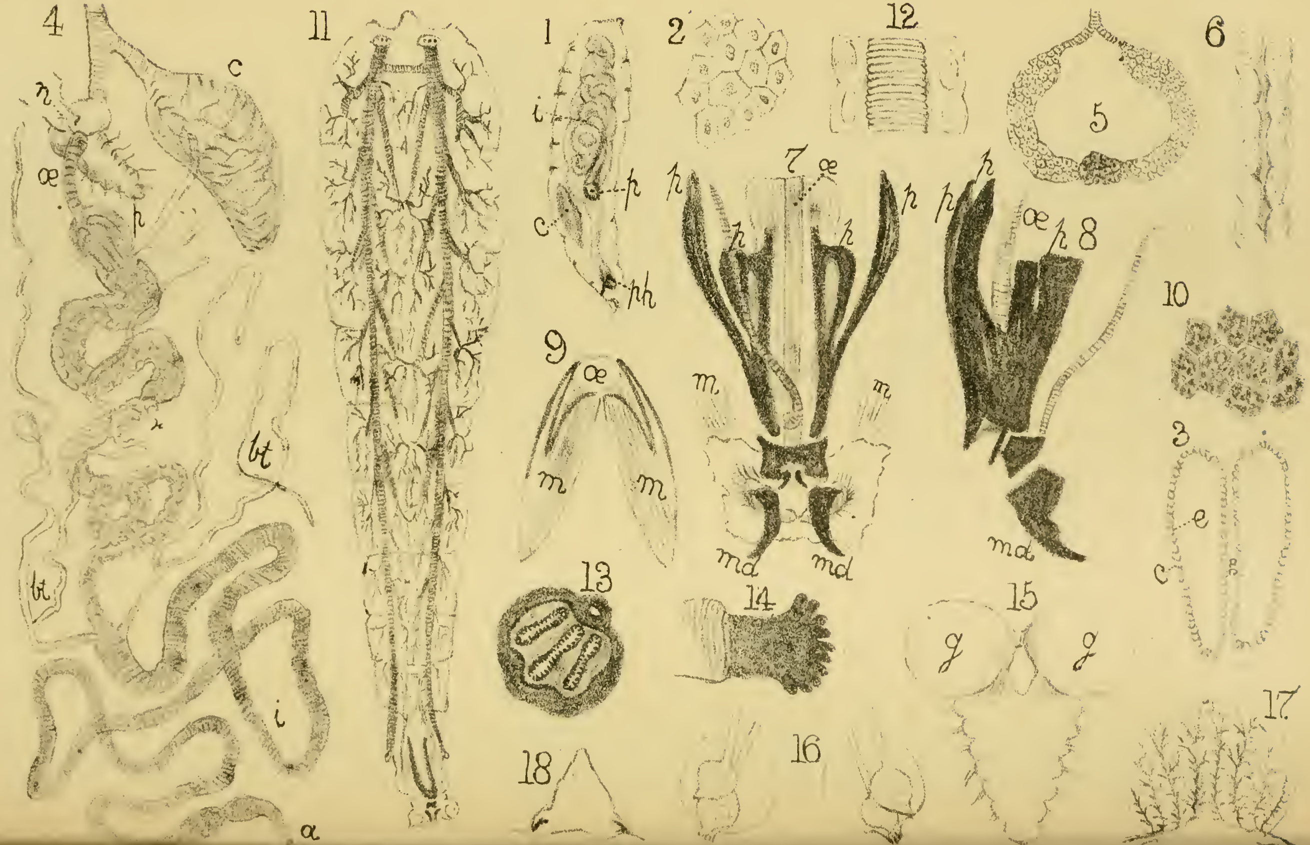
When the specimen is thin enough, and the beech can be well seen through it, I give it a few light rubs on the Water-of-Ayr stone, using water. The specimen can then be taken off the wood and mounted in Canada Balsam, under a thin cover glass.

Remove with a wet cloth all the gum from the edge of the specimen, and thoroughly clean the wood of all impurity. Boil the kettle. Stick the blade of a pen-knife into the side of the beech, to act as a handle, and hold the specimen in the steam from the kettle-spout till it condescends to slide down the face of the wood. There need be no fear of its falling off. The water from the steam will prevent this. It may come off in less than five minutes, or it may take half-an-hour. Do not get impatient. To beguile the time, you may theorise about the size and number of the imaginary spaces that intervene between the molecules, or atoms, that build up the rock, and the size of the water molecules which are trying to find their way through these spaces, in order to dissolve the gum arabic fixing the specimen to the wood. If the specimen takes a long time to come off, you are very apt to conclude that the water "molecules" are too large to find their way through these spaces, and that they are laboriously "working their passage" underneath the specimen. Do not try to hasten the process by "nudging" the specimen with the edge of the knife-blade; this will only end in a vexatious smash. You *must* wait. After all, on an average, about a dozen specimens can be "steamed" from the wood and mounted in balsam, in about two hours. With every care, a specimen will sometimes break in two or more pieces, but you must just take advantage of this "multiplication by division," and make a slide of each fragment. The specimen having at last become loose on the wood, you must heat a glass slide over an argand burner. Take a pen-knife, and with the blade, move the specimen *gently* to the edge of the wood. Put the knife-blade under the edge that projects beyond the wood; steady your hand on the side of the wood, do not attempt to lift the section, but *draw* it off the wood gently; the water from the condensed steam will keep it attached to the knife. Put a drop or two of warm balsam on the heated slide. Have ready a slide template covered with paper, having a circular hole cut in the middle of it, five-eighths of an inch in diameter, or the same size as the specimen, as shown in Fig. 4. Put the template under the heated slide, holding both in the left hand.

Fig. 4.



Dry the *free* side of the specimen (still on the knife) over the argand lamp. Place the specimen gently on the balsam, directly over the hole in the template. Draw the knife off *sideways*. If you attempt to *lift* it *up*, the specimen will break in pieces, the water holds the section so firmly to the knife. Heat a three-quarter inch glass cover over the argand lamp, and put two drops of balsam on it. Lay it *gently* on the specimen, which by this time should be *perfectly flat*. Do not squeeze; heat the template, slide, and section over the lamp, and let the balsam gently boil, to expel the air-bubbles. Again, do not squeeze, but keep the object in position over the template with the point of the knife-blade. Allow the slide to cool a little. Now gently squeeze down the glass slip so as to expel all superfluous balsam.


4
n
c
œ
p
bt
bt
i
a
11
1
i
p
c
ph
2
12
5
6
9
œ
m
m
7
œ
p
p
p
p
m
m
md
md
8
p
p
œ
p
md
10
3
e
c
ac
13
14
15
g
g
16
17
18

The specimen is thus safely mounted and entirely free from air-bubbles and dirt. In this way, I have made hundreds of transparent sections of Traps, Basalts, Porphyrites, Pitchstones, Obsidians, Granites, Limestones, Flints, Agates, Jaspers, Fossil wood, Teeth, Corals, etc. This process is also suitable for making transparent sections of Bone, Ivory, etc., and is much superior to the old method of rubbing down a specimen fixed with balsam to a glass slip. I have tried both methods. You may now enjoy the fruit of your labours, by examining the finished section under the microscope.

Many rock-sections show very fine natural colours, but the polariscope works wonders in giving splendid shades of colour and defining the crystalline structure of the Igneous rocks; whilst on the other hand, many Limestones, Black-Band Ironstones, etc., are seen to be made up of myriads of minute fossil organic structures, closely compacted together in a "paste" of granular matter.

In selecting specimens of Traps, Limestones, etc., for sectionising, too much care cannot be used in taking notes of the position, formation, and locality from which each specimen is procured. When a specimen loses its "pedigree," it at the same time loses the greater part of its scientific interest and value.

The Maggot of the Blow-Fly.

By A. Hammond, F.L.S.

Plate 20.

THE Anatomy of the Blow-Fly, has, as perhaps most of our members are aware, formed the subject of an exhaustive memoir by Mr. Lowne, in which, however, with the exception of certain details of development, little comparatively is said about the larva or maggot. I propose giving a few notes of my own observations on this subject, for the use of our members. I think it will scarcely need an apology for its introduction to a Microscopical Society, as every detail must needs be worked out by the aid of that instrument.

The body of the maggot (Fig. 1) consists of 13 segments, including the head. Limbs are totally absent, and locomotion is effected by the muscular contractions of the body, aided by a zone of sharp recurved points, with which every segment is provided. The integument of insects consists of two layers: an external structureless membrane or cuticle, and an internal cellular epithelium. In the latter may be distinguished an external pigmentary layer, where the cells are rendered angular by mutual pressure, and to which the colouration and hardness of the integument is due, and a soft internal layer of spheroidal and nucleated cells. With the exception of the recurved points just alluded to, where a certain amount of colouration and induration is present, the skin of the maggot presents only the inner soft layer, the cells of which, measuring roughly 1-500th of an inch in diameter, are represented in Fig. 2.

The integument is reflected inwards at the mouth and at the anus to form the alimentary canal, which has also two coats—an outer membranous, and an inner cellular one. It is difficult, however, to regard them both as continuous with those of the external integument, since that which is external in the one is obviously internal in the other, and *vice versa* (see Fig. 3). After passing through the pharynx, an organ to be presently described, the œsophagus divides into two branches, one of which shortly enters the crop, a large oval sac (*c.*, Fig. 4), which may generally be seen by its dark colour, through the integument of the dorsal surface of the larva. It forms a reservoir for the food before its passage into the stomach, and is usually filled with dark brown contents. In *Tanypus*,* it will be recollected, the crop is a simple enlargement of the canal preceding the proventriculus. Here, however, the enlargement seems to have taken place on one side so as to form a deep pouch or sac. That the walls of this sac are muscular is evidenced by an hour-glass constriction which occasionally passes down them, keeping the contents in motion. The other branch of the œsophagus, after passing through the great nerve-centres of the insect, enters the proventriculus, which is a globular chamber with thick cellular walls, formed by a reflection of the œsophagus upon itself, the termination of the latter, hanging

* See this Journal, vol. 1, p. 83.

freely in the cavity thus formed. At the base of the cavity four long cæcal appendages arise, the homologues of those which in greater numbers and much smaller in size surround the proventriculus of *Tanypus*. The distribution of the tracheæ in this organ, as in other parts of the alimentary canal, may be seen to great advantage in the freshly killed insect. The superficial tracheæ are shown in Fig. 17, but others dip down into the space between the termination of the œsophagus and its reflected wall. The proventriculus is followed by the ventriculus or stomach, an organ of considerable length extending to the insertion of the bile tubes. Here the epithelial lining is very distinct, the cells being about 1-300th of an inch in diameter, and filled with granular contents. The function of these cells is doubtless the secretion of a gastric juice for the purpose of digestion. From the insertion of the bile-tubes, a long-coiled intestine of less diameter than the stomach extends to the anus; here the epithelial wall is very little developed, but a coating of longitudinal and circular muscular fibres is very clearly seen, and here probably absorption chiefly takes place.

In connection with the alimentary canal we find the salivary glands (Fig. 5) and the bile-tubes (Fig. 6); the former open by a common ringed duct, indistinguishable from a trachea, into the pharynx; they are lined with nucleated epithelium, 1-400th of an inch in diameter, and are sausage-shaped, their extremities being bound together by a mass of fatty rete. The bile-tubes are four in number, uniting in pairs just previous to their insertion at the extremity of the stomach.

The pharynx has been referred to lately in our note-books as the skull. I think it will be admitted that a skull ought to have in it something of the nature of brain, but inasmuch as the great nerve-centres of the larva which represent its brain lie wholly outside this organ, we must take it, that this nomenclature is scarcely applicable. Both in the larva and in the perfect insect this organ is a sucking instrument, and its construction is essentially the same. The horny parts (Figs. 7, 8, and 9) of which it is composed are extended backwards in the form of four processes, and they enclose the commencement of the œsophagus and a pair of internal transverse muscles; they are moreover provided with powerful external muscles. From a consideration of Fig. 9, it will be apparent that the contraction of the muscles *m.m.* will withdraw the superior wall of the œsophagus from the inferior wall, thus enlarging its capacity and producing an inflow of the fluid aliment upon which the fly feeds; the tissues of the meat having been reduced to this semi-fluid condition by the tearing process of the mandibles, aided probably by the solvent action of the salivary secretion poured out for the purpose. The approximation of the pharyngeal walls to their former condition, and the further propulsion of the food into the œsphagus and crop is probably effected by the external muscles. In front of the pharynx there are two or three small pieces terminating in the mandibles, to the base of which powerful muscles are attached, and by which their movements are effected, as recently shown, I think, by the Rev. J. H. Green, in a slide circulated by him. Beneath the mouth a small fleshy conical labium may be perceived.

In all insects a web of fibrous and fatty tissue intervenes between the alimentary canal and the body-wall. A portion of this fatty rete is shown in Fig. 10, the cells are about 1-300th of an inch in diameter and are filled with oil globules and granules, which render them white by reflected, and dark by transmitted light.

The tracheal system of this larva is a very favourable subject for study, the tracheæ showing out silvery white by reflected light, so that all their ramifications are visible. Two main branches extend from the posterior spiracles the whole length of the body, their ultimate ramifications extending around the sensory-ganglia in the front of the head; a strong transverse branch connects them close to their origin in the thirteenth segment, and another near the head in the third segment. In every segment branches proceed from these main trunks, some of which anastomose with each other in the central line, while others proceed to the muscular, nervous, and digestive system (as seen in Fig. 11).

The tracheæ consist of two coats: an inner coat, corresponding to the outer layer of the integument, of which it is the continuation, and an outer epithelial coat corresponding to, and continuous with, the inner epithelial lining of the integument (see Fig. 12). The spiracles in the mature larva are four in number—two in the last segment, placed in the centre of a circlet of blunt, conical processes which terminate the body, and two in the second segment. These are shown in Figs. 13 and 14. It is not until the larva has somewhat grown that the anterior spiracles are at all developed. Both the spiracle itself, and the tracheal branch that connects it with the main trunk are totally wanting in the newly-hatched larva. The development of this tracheal branch is denoted by the appearance of its epithelial coating, as yet devoid of any cavity or spiral fibre.

Of the muscles I have little to say, beyond the fact that the internal surface of the integument is clothed with a layer of muscular bands, arranged chiefly in a longitudinal direction, and consisting of striated muscular fibres enclosed in muscle-sheaths (myolemma). They are attached at either end to the integument, and by them the movements of the body are effected. Tracheal twigs can be seen distributed over the surface of the myolemma, but I do not think they penetrate it. Nerve-filaments are also doubtless distributed to the muscles, though I have not as yet traced them in this insect.

The pulsations of the dorsal vessel can be seen through the integument on the dorsal surface. It is largest towards the posterior end of the body. I may mention that in the corresponding part of the dorsal vessel of a *Chironomus* larva I have distinctly seen valvular slits opening and closing with each pulsation; probably, the same thing occurs in this larva. Colourless blood-corpuscles may be seen in motion in those parts of the body-cavity which are sufficiently transparent to admit of it.

The nervous system presents an exceptional and very condensed form. Instead of a chain of ganglia connected by a double nervous cord, as in *Tanypus*, and indeed in most other insects, the ganglia are all collected together to form one large nervous mass, surrounding the œsophagus and situated in the third segment (Fig. 15). The two large spherical ganglia, *g.g.*, in this figure represent the cephalic ganglia or brain of other insects, here, however, removed from the first segment, so that the larva can scarcely be said to have a head. This is probably connected with the almost entire suppression of special sensory organs, which are represented by two pairs of papillæ on the front of the head (see Fig. 16), beneath which are spherical masses of ganglion cells connected by large trunks to the nerve-centres. The remainder of the nervous mass is sub-œsophageal, and probably consists of twelve ganglia blended together, one for each segment. From this, nerves, accompanied by tracheæ, are given off to the various parts of the body. The nerve-centres are surrounded by the growing imaginal discs, from which the limbs of the fly are developed. I have not been able to work them out fully. They are, however, well described in Mr. Lowne's book, and consist of cellular expansions attached to the nerves and tracheæ.

Much of the structure of this maggot may be seen by simply compressing it in a live box or compressorium, and viewing with a low power. If it be placed in a little water in a watch-glass, under a lens, and cut in half, the viscera will be immediately extruded, and with the aid of one or two needles may be placed for examination under the microscope, when nearly all I have described may be seen.

EXPLANATION OF PLATE XX.

Fig. 1.—Organs of Maggot seen sideways: *ph.*, pharynx; *c.*, crop; *p.*, proventriculus; *i.*, convolutions of intestine.

Fig. 2.—Epithelial cells of integument as seen under a ¼-inch objective.

Fig. 3.—Diagram showing relations of inner and outer coats of integument: *c.*, outer cuticular layer; *e.*, epithelium; *a.c.*, alimentary canal.

Fig. 4.—Alimentary canal: *œ.*, œsophagus; *c.*, crop; *n.*, nerve-centres; *p.*, proventriculus; *cœ.*, cæca; *v.*, ventriculus; *i.*, intestine; *a.*, anus; *b.t.*, *b.t.*, bile-tubes. The salivary glands are shown separately.

Fig. 5.—The salivary glands.

Fig. 6.—Bile tube.

Fig. 7.—Pharynx, front view: *p.p.p.p.*, processes; *œ.*, œsophagus; *m.d.*, *m.d.*, mandibles; *s.d.*, salivary duct; *m.m.*, muscles of mandibles.

Fig. 8.—Ditto from the side, letters as before.

Fig. 9.—Transverse section of ditto; *m.m.*, muscles.

Fig. 10.—Cells of fatty rete.

Fig. 11.—Tracheal system.

Fig. 12.—Portion of trachea, showing coats.

Fig. 13.—Posterior spiracle.

Fig. 14.—Anterior ditto.

Fig. 15.—Nerve-centres; *g.g.*, cephalic ganglia.
Fig. 16.—Sensory cephalic papillæ with ganglia.
Fig. 17.—Distribution of tracheæ over proventriculus.
Fig. 18.—Labium or under lip.

On Mounting Diatoms, &c., in Lines and Patterns.

From "The Journal of the Victoria Microscopical Society."

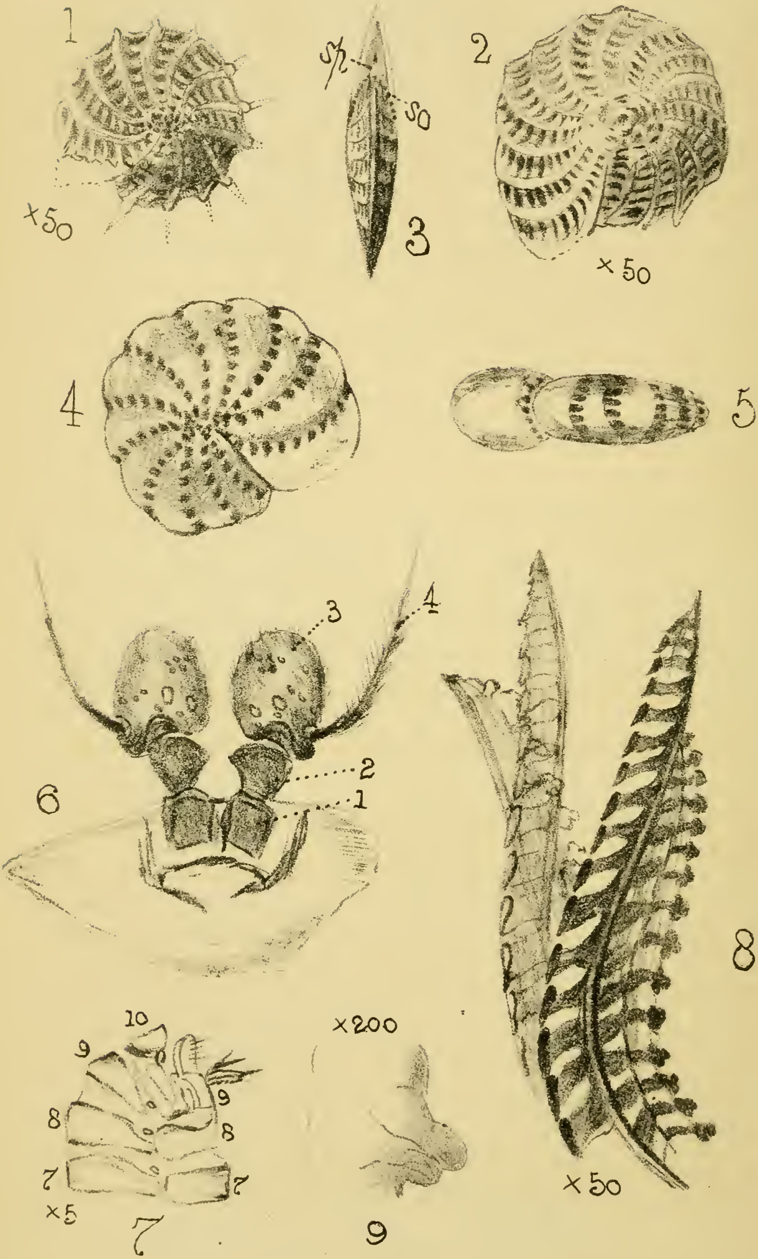
MR. H. Sharp gives the following directions for this kind of mounting, his slides thus prepared being said by Mr. W. H. Wooster to be "exquisite examples of manipulative skill":—

"*Requisites.*—(1) One or two cat's or mouse's whiskers fastened on match-like sticks or fine rushes, with shellac rather than gum, with about $\frac{1}{4}$ inch free. I prefer to have one with the natural point, and another with the point cut back to where it is somewhat stiffer. (2) A good simple Microscope of some kind, either attached to a roomy stage-plate, with a mirror below and revolving-plate above, or detached on some stand, cut capable of being brought over a mounting-table with mirror and rotating plate as above. My own is home-made, extremely simple, costing nothing but the trouble, and such as any one with a little ingenuity could make for himself. It consists of a piece of pine 9 inches long, 5 inches wide, and 1 inch thick, on three legs, with a hole in the centre, into which a wooden matchbox (with the bottom cut out) fits tightly, projecting a little above; over this fits a piece of slate just tight enough to rotate easily; beneath, a peg receives the mirror of the Microscope. This forms the detached mounting-table. For the simple Microscope, I take the foot and tube-pillar of the condenser, fit a piece of cane in this tube, drive a pickle-bottle cork stiffly on it, and fasten on this a horizontal wooden bar with a hole in the middle to fit on the cane, and another at each end in which to fit the lenses, which are just the $1\frac{1}{2}$-inch and

½-inch objectives, which give far better definition than common pocket-lenses. (3) A steady hand. (4) Patience and perseverance.

Dry Mounts.—All diatoms and scales should be mounted on the cover, not the slide. Lay a clean cover on a slide and keep it in place by a drop of water between. As scales are larger than diatoms, it is well to begin with them. Put several on a slide in the ordinary way, pick out the ones wanted with a bristle under the simple Microscope, one at a time; keep the cover flooded with moisture from the breath, and deposit the scales picked up wherever wanted in lines or patterns. They will readily leave the bristle for the wet glass, and can be pushed about quite easily. When the moisture dries off no stain is left, and the objects will adhere with sufficient firmness to resist anything short of a sharp jar. When the line or pattern is finished, mount in a shallow cement cell.

Balsam Mounts.—The cover must have a film of a gelatinous nature which is insoluble in balsam and its solvents. A thin aqueous solution of isinglass carefully filtered serves well. A single drop is placed on a clean cover, and spread out as thin as possible with a clean needle. It dries almost instantly in warm weather, and in a few seconds in winter. A diatom placed on this film and *gently breathed on* is securely sealed, and cannot be dislodged without moisture. Care must be taken to place the diatom in position while the film is quite dry; then breathe on it; allow the film to dry again; then place another diatom, and so on, till the line or pattern is finished. If any of the diatoms are thick or likely to be crushed, stick three bits of cover-glass under the edge of the cover with gum, and place a dot of gum on each before placing the cover in position on the slide. This, when dry, will keep the cover in its place while introducing the balsam, before doing which, allow a little benzine to run under by capillary attraction, which soon displaces the air from the diatoms. Then apply a little balsam to the edge of the cover and a bit of blotting-paper to the opposite edge. This draws away the benzine, and the balsam follows and takes its place. Another plan is to gum a piece of good cream-laid paper on the slide, centre on the turn-table, and make two cuts through the paper, removing the middle and outer portions and leaving a ring of paper to form a cell as


1
×50
sh
so
3
2
×50
4
5
3
4
2
6
1
8
×50
10
9
9
8
8
7
7
×5
7
×200
9

large as the cover; then cut two small openings in opposite sides of the ring, gum the top of the cell and place the prepared cover on the gummed surface. When dry apply benzine to one of the small 'sluice gates,' and then balsam as before. Put the slide in a warm place for several days, and finish off with white, black, or coloured varnish to fancy. Winter is the best time for dry mounts, as the breath dries off too soon in hot weather; and summer is the best time for the balsam mounts, as it is difficult in the winter to keep the breath from moistening the isinglass at the wrong time. The cement-cells should be quite dry and hard before mounting, or a dewiness will appear and ruin the object. Soften the cement over the lamp, press the cover down till it sticks all round, let stand a day or two, and finish off. No doubt the diatoms would be more secure if burnt on the cover in the dry mounts, and possibly that process would be sufficient for the balsam mounts without the film of isinglass, as stated on p. 68 of Davies' Manual of Mounting."

Half-an-Hour at the Microscope,

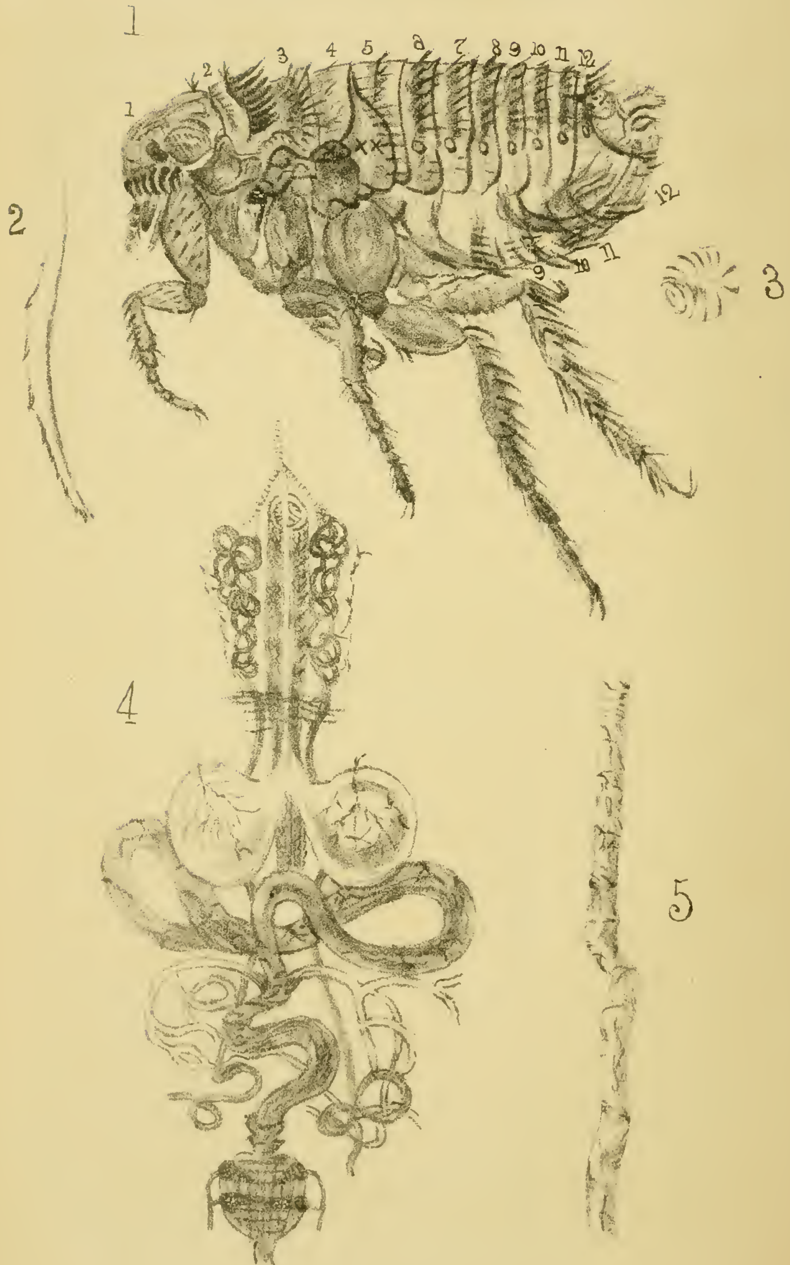
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

ON receiving a box of slides, the first thing I do is to arrange the slides in order, and I strongly recommend this as a valuable aid to the methodical classification of facts in the mind.

The FORAMINIFERA claim the first place. The DIPTERA are placed by Westwood lowest amongst the Insects; Antennæ, as outward organs, precede the stomach as an internal one. Fleas are considered to unite this order with HEMIPTERA (Bugs, etc.); HYMENOPTERA (Wasps, Saw-flies, etc.), being more highly organised, will follow on. *Itch Mites* may be taken to stand lower in the scale than the active, highly-organised *Gamasi*.

On **Polystomella crispa** (Pl. 21, Figs. 1, 2, 3), Prof. Williamson says:—"This exquisite species appears to have attracted the attention of a larger number of Conchologists than any other of the *Foraminifera;* a circumstance not surprising when we bear in mind its conspicuously striking aspect, and its wide diffusion." "Shell spiral, equilateral, compressed laterally, lenticular; revealing only the outermost convolutions, which consist of from twelve to thirty narrow, arenate, flexuose segments; the anterior border of each segment prominent, smooth, forming a raised septal line; the central portion and posterior border more depressed, sometimes concave; and sculptured into numerous transverse, alternate elevations and depressions, which are most conspicuous near their junction with the antecedent segment." "Peripheral margin . . . usually thin and angular, often with small obtuse tubercles projecting from the septal ridges of a few of the posterior segments. Young shells with these tubercles developed into long, pointed, transparent spines projecting from each of the segments, those of the outermost convolutions being the longest and most acute. Septal plane sagittate. Septal orifices numerous, arranged in a line which runs close to the surface of the antecedent convolution, and forming two lateral series, thus :  meeting at an angle of the periphery of the latter." This shows the importance of considering different aspects of the shells.

Polystomella umbilicatula (Pl. 21, Figs. 4, 5) is considered even by Professor Williamson himself to be a very doubtful species. He says:—"Some matured specimens of this shell are very difficult to distinguish from young spineless varieties of *P. crispa*, in which latter the peripheral margin is less compressed and acute than usual; and the question of their distinctness or otherwise depends upon the value we assign to the form of this margin." The "septal lines are depressed; masked by the crenulations furrowing the posterior border of each segment," (which cover a much shorter distance of the segment,) "septal plane cordate." "Mr. Hyndman, of Belfast, forwarded to me a large number of specimens of this shell, obtained from the stomach of a Sheldrake shot in Belfast Bay. They were unmixed with any other species of Foraminifera, though along with them were numerous species of Marine Entomostracous Crustaceans. We can scarcely suppose that the bird had been naturalist enough thus to select individuals of so minute a species by way of *bonne bouche;* it is more probable that they had previously been devoured by some of the marine Mollusca or *Acalephæ*, which had subsequently fallen a prey to the feathered biped. But the animal, whatever it was, obviously distinguished between *Polystomella* and other *Foraminifera*. I have never met with any form in such numbers, and so free from admixture with other species, as to enable a discriminating feeder to fill its stomach with it. Is this a collateral testimony to the reality of


1
2
3
4
5

the species?"—("Williamson's Recent Foraminifera," Ray Soc. publication, pp. 41—44, and Pl. III., Figs. 78—82.)

On Species in Foraminifera, I would request a thoughtful perusal of Prof. Rupert Jones's Communication to the Roy. Micro. Soc., "On the Foraminifera, with especial reference to their Variability of Form, illustrated by the Cristellarians," in the Monthly Micro. Journal, Feb., 1876, p. 61.

Antennæ of Insects.—The minute structure of these organs has formed the subject of some important communications to the Linnæan Society by Dr. J. Braxton Hicks. They will be found in its "Transactions," Vol. 22, pp. 147 and 383, with several plates. The third joint in many of the Diptera is greatly dilated, as is seen in those from the *Syrphus* (Pl. 21, Fig. 6), where the remaining joints are represented by a long, stout, plumose seta. The transparent dots in the third joint are thin places in the integument, to which nerve-filaments can be traced. Each spot has a fine, short hair arching over it:—the larger spaces appear to be formed by a confluence of the smaller dots. These organs are the seat of some special sense. Dr. Hicks thinks their anatomical structure renders it probable that they are organs of hearing. R. B. Lowne takes them for organs of smell. The subject is one of much difficulty, and it would be premature to give an opinion either way as yet, especially when viewed in connection with Sir J. Lubbock's recent observations on Bees, Wasps, and Ants (Proc. Linn. Soc., 1875), whereby attempts were made to elucidate the subject experimentally.

Stomach of Blow-Fly, Plate 22, Figs. 4, 5.—The drawing, Fig. 5, represents all that may be seen on this slide with a low power. I have supplemented it with a reduced copy of Mr. B. T. Lowne's very excellent drawing of the alimentary canal, with the œsophagus and crop, the chyle stomach, and salivary glands, etc. For a full description, see "The Anatomy of the Blow-Fly," by B. T. Lowne, page 54, plate 4.

Flea from Cat. (Pl. 22, Fig. 1.)—With regard to this slide, I would direct attention to some amusing and interesting notes by the indefatigable S. J. McIntire, on *Cat Fleas*—their eggs, larvæ, and life-history generally. They will be found in Sci. Goss. for 1865, p. 278; 1866, p. 46; and 1867, p. 47. In the same periodical for May, 1871, is an article on Fleas generally; it has no signature, which is a serious and too-common defect, but may be assumed to be by the then Editor, M. C. Cooke. In this at p. 71 is a figure (Fig. 56), that appears to agree with the present example; it is said to represent the *Dog-Flea!* At page 214 (1867) occurs the following, signed "E. Marks":—"CAT-FLEAS.—In Mr. McIntire's article under this title (Sci.

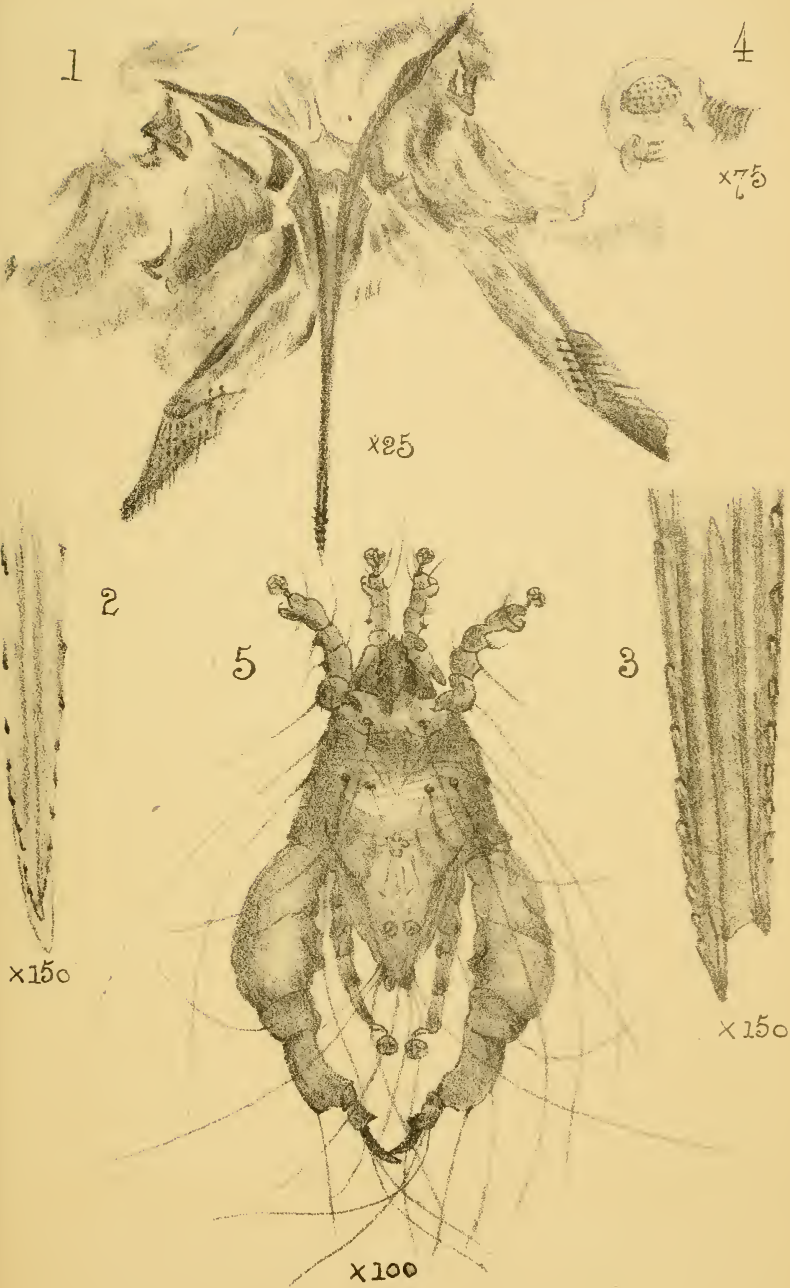
Goss., Vol. 1, p. 278) a figure is given showing the spinous fringe on the underside of the head and on the pro-thorax, which agrees with my own observations of this species. In the 'Micrographic Dictionary,' article 'PULEX,' the *Dog-flea* is described as the possessor of these appendages, and the head of the *Cat-flea* is referred to as 'naked.' The figures on Pl. 28 correspond to the letterpress. I shall be glad if some 'gossiper' can enlighten us on this discrepancy." Keeping neither Cat nor Dog, I am at present equally puzzled with the above writer, and hope some member will answer the question by sending round the *genuine article* "warranted."

Have both Dog- and Cat-fleas the same frontal and pro-thoracic fringes? and if so, how can they be distinguished? My own belief is that the figure in the "Micrographic Dictionary" (9, Pl. 28)—which was copied from a drawing supplied to me; not from a specimen, and therefore I disclaim all responsibility in connection with it—represents the human flea. If so, does the latter tickle Cats? as well as *vice versa.* I feel sure that if the species (*P. canis* and *P. felis*) be distinct, that there will be characters recognisable, on sufficiently careful examination, whereby they may be discriminated. The relative lengths of the posterior tarsal joints are given in Micro. Dic. (*sub. P. felis*), as 1, 5, 2, 3, 4 (*sub. P. canis*), as 1, 2, 5, 3, 4. My own belief is that the parts of the mouth will furnish important characters, but they do not appear to have been sufficiently studied. Don't let *us* say, with an exquisite of the "Lord Dundreary" type, to a lady on his arm at one of the Royal Microscopical Society's Soirées, that "it wasn't pleasant to have so many examples of such nasty things" (as fleas, bugs, lice) "shown when WE (!) come to these soirées." That is not the scientific spirit I desire to see cultivated by our members. *All* things have been pronounced by Him who made them "good." All are the work of His fingers, "for whose pleasure they are and were created." All are wonderful, and deserve our most thoughtful study. Let the motto, "*Naturæ opera maxime in minimis*," be habitually in our minds.

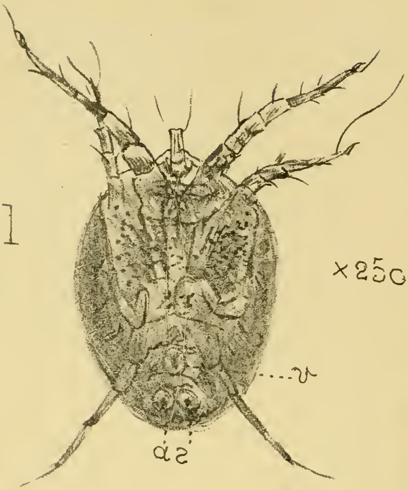
Saws of the Saw-Fly.—This unnamed specimen, of which I have given a drawing (Pl. 21, Figs. 7, 8, 9), furnishes a good example of the parts found in some of the *Tenthredinidæ*—true "Saw-Flies"—but of these 341 species are mentioned by Westwood (Intro. to Modern Classification of Insects, Vol. 2, Appendix, p. 55), distributed into 45 genera!!

The habits of some species of *Allantus* are mentioned by this author (Ibid, p. 100).

The Sting of Sand-Wasp (Pl. 23, Figs. 1 & 2) is both interesting and novel, and furnishes a good example of the kind of work I


1
4
×75
×25
2
5
3
×150
×150
×100

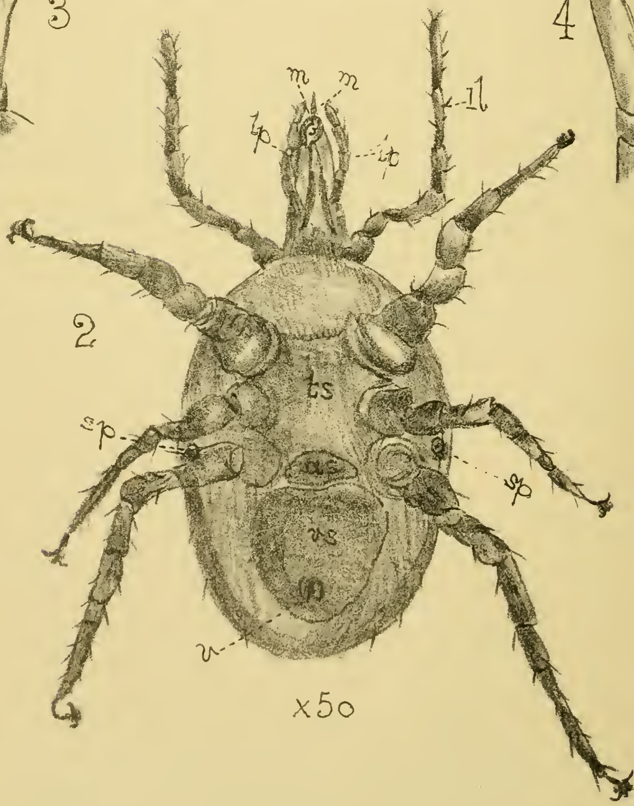
1



3

4

2



hope to see our members engage in. It is true, as remarked by C. F. G. (see p. 52), that the weapon here is very different from that of the *Allantus*, but then so are its uses. Saw-flies have to make incisions in the bark or leaves of trees wherein to deposit their eggs, and therefore need powerful saws. Our *Ammophila* has merely, by piercing the tender skin of Caterpillars or Spiders, to render them insensible till the larvæ forming its brood may be ready to feed upon them. The parts in *Ammophila* compare much more closely with those in the Wasps—still, the latter are specially weapons of defence. Some most interesting observations on the habits of *Ammophila* will be found in Westwood (Mod. Class. Insects, Vol. 2, pp. 205, 206).

Acarus from Finch. (Pl. 23, Fig. 5.)—It is to be regretted that the exact species of Finch from whence it was procured is not recorded, as from a scientific point of view this has real importance.

Birds must be subject to the complaint vulgarly called "Scotch fiddle," or more politely "The Itch," to an extent of which there could be no idea till the microscope revealed the number of such parasites by which they are infested. I have many of these Acari myself, but think the present one is not amongst them. There appear to be few birds not infested by at least two species; it is a common thing to find three, and I possess examples of *five* different species, taken from some Water-bird. The one shown here is a male; the females in this genus differ very greatly in appearance from their mates. I find them most readily on the pinnæ of the principal wing-feathers, by holding the latter up to the light; here at times they may be found congregated in great numbers.

Hypopus muscarum. (Pl. 24, Fig. 1.)—The genus *Hypopus* is probably a very large one. Through the kindness of various friends (for the most part) I have had the opportunity of studying numerous species. Some are sluggish in their habits, others run very rapidly. How do they find their prey? They have no visible eyes, it is true; but many of their congeners are in the like case. I think it likely to be through an exalted state of touch in the long tactile setæ terminating the limbs, which represent the whiskers of feline animals, whereby the latter can steal on their prey through the deepest shades of night. They appear to lurk under stones. S. J. McIntire confirms this observation. His remarks will be found in a paper headed "Notes on so-called *Acarellus*," in the Monthly Micro. Journal for Jan., 1874, p. 1. He found them in some "Cork-Cells," wherein were also "*Potato-Mites*," and considers that the latter became transformed into *Hypopi!* This appears to me most improbable. Both, from the presence of the four pairs of limbs, may be supposed to be adult forms. Much careful work is required to elucidate their life-history. Reference is made by S. J. McIntire to some observations by J. G. Tatem, reported in a previous part of the same periodical. The *Hypopi* have a curious habit of drawing up the hinder limbs towards the head, whereby it is often exceedingly difficult even to see them.

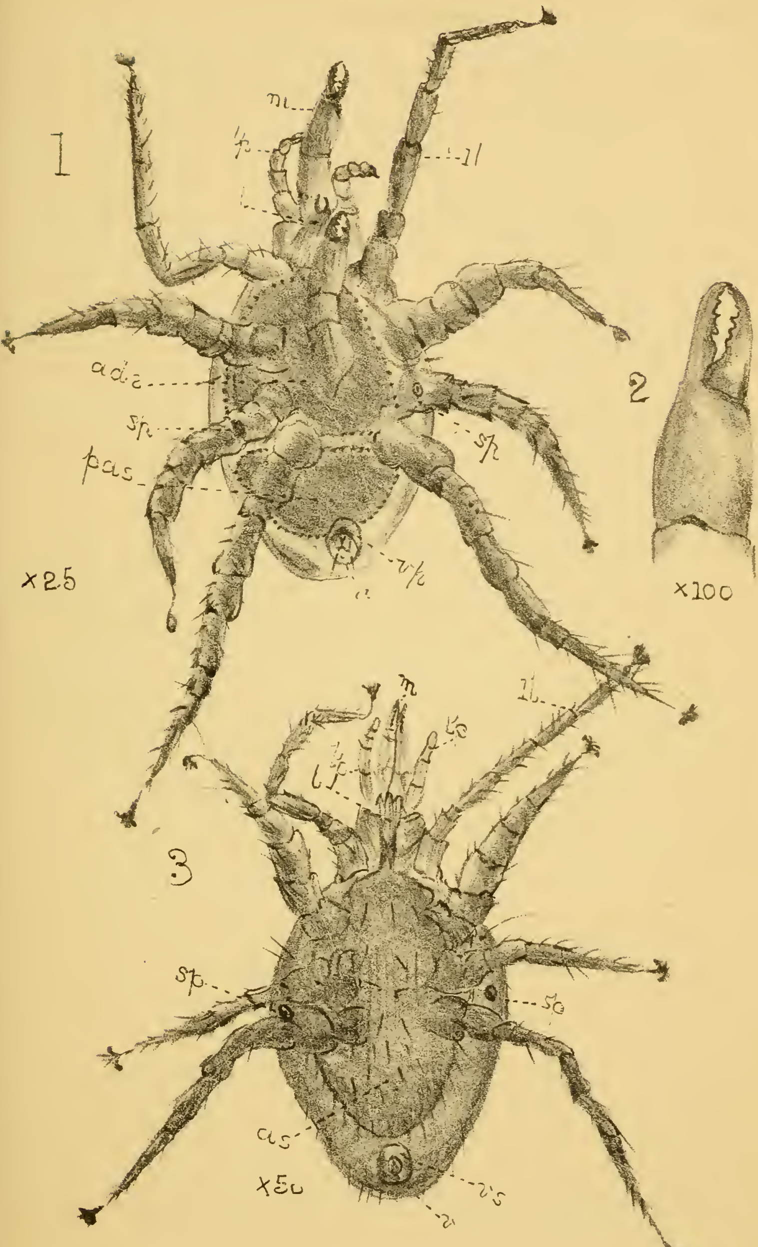
Gamasus from House-Fly. (Pl. 24, Figs. 2, 3 4.)—I cannot give the specific name, though familiar with the creature. I find it commoner on small flies of two or three species, frequent on the window-panes in June, than on *Musca domestica* (THE *house-fly*). The chelate mandibles of these creatures are very remarkable.

Gamasus coleoptratorum. (Pl. 25, Figs. 1 and 2.)—This is the special parasite of the Dung-beetle (*Geotropus stercorarius*), and from the length of limb in proportion to the body is probably a male. In some members of the genus, however, the limbs of the second pair are, in this sex, specially modified as powerful prehensile organs. Mr. Atkinson's account (see p. 56) of the readiness shown by the present fellow to "put itself outside other Acari" is vastly amusing. I can confirm the description by my own experience, though my omnivorous capture belonged to a different genus.

Gamasus from Rat. (Pl. 25, Fig. 3.)—This is probably the one figured and described in Sci. Goss. for October, 1868, p. 232, as from a Mole, though both representation and account are exceedingly imperfect. We must not be too impatient to give these things names; many of them have been as yet but very imperfectly investigated. Our object should be to investigate structure and life-history minutely and accurately, and to add to knowledge.

Dermanyssus.—I am familiar with two species of *Dermanyssus*, and have others awaiting study. One of those I know, *D. gallinæ*, is at times a great plague to fowl-keepers; the other, *D. avium*, is no less an annoyance to those who have pet canaries and other singing-birds. Figures of *D. gallinæ* will be found in Part 2 of a "Descriptive Catalogue of the New Sydenham Society's Atlas," by the Honorary Secretary, Jonathan Hutchinson (Pl. 4, p. 87); in which work are also contained original figures of Itch-Mites from some of the lower animals which occasionally (like *D. gallinæ*) wander to man, and give rise to more or less serious affections of the skin.

TUFFEN WEST.


1
m
lp
ll
ads
sp
pas
sp
vp
x25
2
x100
3
m
ll
sp
sc
as
vs
x50

EXPLANATION OF PLATES XXI., XXII., XXIII., XXIV., XXV.

Plate XXI.

Fig. 1.—Represents one of the young specimens of *Polystomella:* the dotted lines show the probable length of the spines in their perfect condition.

,, 2.—A mature example.

,, 3.—Periphero-lateral aspect of the same after Williamson; *s.p.*, septal plane; *s.o.*, septal orifice. The above are magnified 50 diameters.

,, 4.—Lateral aspect of *P. umbilicatula.*

,, 5.—Periphero-lateral aspect of the same after Williamson.

,, 6.—Antennæ of *Syrphus.* 1.—The Basal. 2.—The Second. 3.—The greatly enlarged and club-shaped Third joint. 4.—The plumose setæ.

,, 7.—Ovipositor of Saw-Fly as seen with a low power. The numbers indicate those of the abdominal segments. 7, 8, and 9, show the possession of spiracles, × 5 diam.

,, 8.—The saws, with the saw-hooks, × 50 diam.

,, 9.—One of the saw-teeth × 200 diam.

Plate XXII.

Fig. 1.—Flea from cat, ♂, × 30 diam. The numbers, 1, 2, 3, etc., indicate the number of the segments, 2 being the pro-, 3 the meso-, and 4 the meta-thorax. On the 12th dorsal segment two long, stout setæ are seen. X, a scale attached to the meso-thorax, representing an anterior wing; X, X, a larger scale connected with the meta-thorax, partly overlapping the dorsal portion of the 5th segment, representing a rudimentary posterior wing.

,, 2.—The Tongue ("*lingua*").

,, 3.—Meta-thoracic spiracle of the left side.

,, 4.—Digestive organs of Blow-Fly, after R. B. Lowne.

,, 5.—The object on slide "Stomach of Blow-Fly" as viewed with a low power.

Plate XXIII.

Fig. 1.—Sting of Sand-Wasp × 25 diameters.

,, 2.—The barbs with their sheath × 150 diameters.

,, 3.—The barbs and end of sheath of the sting of Common Wasp × 150 diam., for comparison.

,, 4.—Spiracle of *Ammophila.*

,, 5.—Acarus from Finch, *Dermaleichus passerinus* (Koch), *Acarus chelopus* (Hermann) ♂, Dorsal aspect, × 100 diameters.

PLATE XXIV.

Fig. 1.—*Hypopus muscarum* × 250 diameters. The ventral aspect is represented. The legs of the third pair are, as is usual, drawn up, so as to be all but invisible. *a.s.*, abdominal suckers, above which is the vent.

,, 2.—Gamasus from House-Fly, ventral aspect, × 50 diameters. *t.s.*, thoracic shield; *a.s.*, abdominal shield; *v.s.*, ventral shield; *v.*, the vent; 1*l.*, limbs of the first pair= modified antennæ; in some *Gamasi*, as the present, these have neither claws nor suckers terminating them, and are strictly organs of touch. *l.*, labium (=lower lip); *l.p. l.p.*, labial palpi; *m.m.*, chelate mandibles.

,, 3 and 4.—The chelate mandibles more enlarged, their direction is vertical, so that of the left side is in its natural position. Fig. 3, by pressure, displays the chelæ in profile.

PLATE XXV.

Fig. 1.—*Gamasus coleoptratorum*, ventral aspect, × 35 diameters. *l.*, labium; *l.p.*, labial palpus of the left side; *m.*, mandible of the left side, that of the right side has been displaced; 1*l.*, limb of the first pair. It will be seen that *G. coleoptratorum* belongs to a section having the first limbs ambulatory and prehensile, and therefore furnished with claws and suckers. The mandibles by pressure show the lateral aspect; *v.*, vent; *v.p.*, small ventral plate with two minute tactile hairs; *sp. sp.*, spiracles; *a.d.s.*, anterior dorsal shield; *p.d.s.*, posterior dorsal shield.

,, 2.—Chelate mandible more enlarged.

,, 3.—Gamasus from Rat, ventral aspect. *l.*, labium; *l.p. l.p.*, labial palpi; *m.*, mandibles; 1*l.*, limb of the first pair; *v.*, vent; *v.s.*, ventral shield; *sp. sp.*, spiracles; *a.s.*, abdominal shield.

These plates are all from drawings by Mr. Tuffen West.

Selected Notes from the Society's Note-Books.

BOTANICAL.

Hæmatoxyline forms a pretty slide. It is obtained by mixing extract of Log-wood with sand, and digesting this powder for several days with about six times its volume of ether. The liquid is then distilled till the residue assumes the consistence of a syrup. If this residue is mixed with water, crystals are in a few days deposited which readily dissolve in boiling water.

J. W. Goodinge.

The use of Log-wood dye, in England, dates from the time of Queen Elizabeth, but the dyers of that period knew so little about its chemical properties that they failed to render the colour of the dye sufficiently permanent; and the prejudice against it consequently became so strong that an Act of Parliament was passed forbidding its use, and ordering it to be burnt where found. This law was of course evaded by introducing it under the name of Black-wood. The law was not repealed till the time of Charles the Second.

E. E. Jarrett.

Acrides hoseum.—A longitudinal section of the leaf of this plant will show under the Polariscope curious long-shaped fibro-cells with a double spiral similar to those mentioned by Carpenter as existing in *Saccolabium guttatum.* In many the spiral is very close, reminding one of the appearance of the cross lines on some of the diatoms.

C. V. Smith.

Quekett, in his Histological lectures, states that, "in most spiral vessels the fibre is single, in others two or more fibres running in the *same* direction form a band, which for distinction is called a compound spiral vessel." In no work that I have access to can I find (except Carpenter's already quoted) any statement of spirals winding in *opposite* directions, "so that by their mutual intersection a series of diamond-shaped markings is produced." May I hazard the conjecture that the reticulated appearance is due to seeing both sides of the spiral vessel at the same time?

I am aware that some vessels have longitudinal as well as transverse striæ, but it seems to me elasticity would be somewhat impaired if the striæ wound in opposite directions; and that different views are entertained as to the striæ coiling to the right or the left. Quekett gives the above as coiling from right to left. Another work on Botany I have before me would describe it as with the spirals from left to right, all depending on the position of the observer. Asa Grey would call the helix sinistrorse, *i.e.*, to the left, presuming the observer to be outside and the coil winding from right to left. Linnæus would suppose the observer to be inside the coil, when it would wind from left to right.

H. Basevi.

This plant is one of a large genus of tropical Orchids inhabiting the warmer parts of Asia. They have distichous leaves, mostly channelled and unequally truncate, but sometimes terete. It is curious that the flowers are of all tints except *blue;* some are very fragrant.

E. E. Jarrett.

Nostoc, when growing, has the appearance of an olive-green, and dark jelly-like substance in folded or plaited masses. Under high power ($\frac{1}{4}$-in. o.g.) it appears as strings of cells, like rows of beads, with, here and there, larger cells—these are called "heterocysts." The threads of cells are enclosed in gelatinous sheaths, which melt together, so that large colonies are the result.

P. L. Smith.

I am inclined to think that the above statement as to the "gelatinous sheaths melting together so that large colonies are the result," not strictly correct. Berkeley, at p. 139, gives description of *Nostochinea* as follows:—"Threads very slender, moniliform, invested with gelatine, which is at length *to all appearance* common to the mass, but at first apportioned to each individual thread; propagation by the division of the threads or by zoospores."

The editors of the Micro-Dictionary are evidently of Mr. Smith's opinion. Under this head they remark, "the amorphous matrix is produced by the fusion of the special gelatinous sheaths of the individual filaments." I myself incline to believe this is only *in appearance.* Nostoc is the typical genus of the *Nostochinea;* the species are very numerous, and are usually found on damp ground, wet rocks, mosses, etc. All are characterised by the necklace of spores, surrounded for the most part with firm and copious jelly; some joints are larger than the rest—they increase by the threads breaking up into fragments, bursting through their common envelope and becoming dispersed in the water; now they have spontaneous motion which soon ceases. Here fragmentary threads divide longitudinally and transversely, at last constituting bundles of new threads. The larger joints in the typical species are not at present understood; Berkeley considers they will eventually prove to be connected with the fructification.

H. BASEVI.

ZOOLOGICAL.

Fish-Parasites.—I am told there is a Jack in the fresh-water tank of the Brighton Aquarium (1876), on whose skin two kinds of parasites are to be found in such large quantities that they are a source of very great inconvenience to his swimming capabilities.

E. LOVETT.

Fleas.—The fleas of animals seem to bear a strong resemblance one to another. I have slides of Dog-flea and also of Ferret-flea, and on comparing with the slide of Cat-flea I notice that the neck-fringe of the Dog-flea is more defined than that of the Cat-flea; but in the Ferret-flea, although the fringe corresponds, the shape of the body is totally different, being more slender and elongated, I have seen swifts and moles swarming with their respective fleas, and I agree with Mr. West that they must in consequence suffer severely at times.

E. LOVETT.

With respect to Cat- and Dog-fleas, I believe the same species is often found on both animals, even if each animal has a species peculiar to itself.

H. M. J. UNDERHILL.

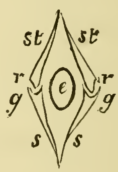
Fleas.—In my experience Human fleas have neither comb on their neck or fringe round the mouth. Bird-fleas have the comb on neck, but no spines round the mouth, and Animal-fleas have both neck-comb and mouth-spines.

H. E. FREEMAN.

Ovipositor of Saw-fly.—Lyonet (Recherches posthumes Plançhe, 15, Figs. 18 and 19,) gives drawings of the saws of *Allantus flavicornis*, which correspond very closely with those represented. Lyonet's description of the saws of these insects may perhaps be interesting, although, doubtless, not new to many of our members. He says (p. 160):—"At first sight the saw appears to be all of one piece, but on closer examination it is found to be composed of four parts—viz., two similar saws, the cutting edges of which incline towards each other, and touch in the same line, and in addition to these, of two stays of almost the same size and shape as the saws, but only so in appearance, the thin edges of which also touch one another.

"The other edge of the stays is thicker and furnished throughout its length with a sliding ridge slightly inclined, which runs in a groove, also slightly inclined on the back of the saw, and allows the latter to slide easily backward and forward without becoming separated, in such a manner that when these four pieces are placed together, they enclose a space through which an egg can be slipped and introduced into an incision made by the saws." I have not made a study of these insects myself, but I apprehend, from the foregoing description, that a section across the apparatus would present something like the annexed diagram (Fig. 5), where *st. st.* are the stays, *s.s.* the saws, *r.r.* the sliding-ridges, *g.g.* the grooves in the back of the saws, and *e.* an egg passing down the passage formed by the four inclined pieces.

Fig. 5.



A. Hammond.

Sting of Sand-Wasp differs widely from ovipositor of Saw-fly, *Allantus*, although a modification of the same organ. The ovipositors differ wonderfully in different species, but when well mounted all make very beautiful objects.

C. F. George.

Sting of Wasp.—Westwood (p. 181) says that the sting of the *Aculeate Hymenoptera* "is composed of a slender, horny, acute dart, channelled beneath and enclosing two spiculæ, which are retro-serrated at the tips, and connected at the base with a poison-bag in both females and neuters, and also with the ovaries in the females.

"This organ is defended while at rest by a pair of lateral plates articulated in the centre and forming together a kind of scabbard or sheath." The annexed diagram (Fig. 6 *) gives a rough representation of these organs. Between them the dark point of the dart, with the spiculæ projecting therefrom, is seen to protrude. The spiculæ seem to arise from their anterior border at *a. a.*, as may be seen in the Sand-Wasp, and travel in a curved groove along their inner edges till they enter the dart which lies between them. A section of the dart is something like the diagram (Fig. 7), the two little black dots showing the position of the spiculæ, which, it may thus be seen, can only be forced out of their channel by violence. Amongst the many curious questions which the subject suggests, I have been somewhat puzzled to account for the exsertion of the spiculæ.

Fig. 6.

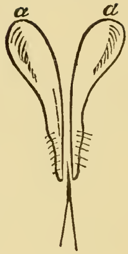
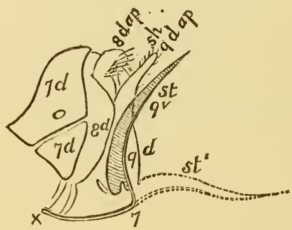


Fig. 7.

I cannot see that they are directly acted upon by muscles, but I gather from Westwood's remarks that the sting when in action is bent away from its position between the sheaths, and, indeed, I find by experiment it is capable of being bent at a very considerable angle, as may be seen by the annexed diagram (Fig. 8), which is a side-view of what *I believe* to be the 7th, 8th, and 9th segments of the abdomen, forming the sexual organs. *7 d. 7 d.* is the seventh, *8 d.* the eighth, and *9 d.* the ninth dorsal plate, *st*—also marked *9 v*, the dart or ventral plate—showing its position in repose, *s. t'.* the same in action, *8 d.ap.* the eighth dorsal appendages, *sh.* or *9 d.ap.* the sheaths or ninth dorsal appendages, *x y* the basal part of the spiculæ.

Fig. 8.



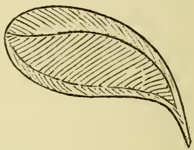
By the above diagram, it may also be seen that in the position of repose, the terminal portions of the spiculæ from the point *y* to the termination of the sting are bent at a considerable angle to their basal portions, *x y*, but that when the organ is called into action, as seen by the dotted portion of the figure, the course of the spiculæ is much straightened, and I think that this straightening and consequent shortening of their course is one cause of their exsertion, which would be thus brought about by the same muscular act, which bends the whole organ from its original position. Nevertheless, I think it not improbable that some other means may be provided for imparting an independent and alter-

* These drawings are from a dissection of the insect I made for the purpose.

nate action within certain limits, to each of the spiculæ, which that I have referred to of course would not effect.

Westwood thinks that the eggs pass through the sting in the act of oviposition, and I think that the groove in this organ is continuous with the vagina; but I am unable at the present moment to ascertain this fact satisfactorily. Into this cavity also the duct of the poison-bag appears to open. I think this organ is the homologue of similar ones found in other insects, though here modified for this special purpose. It is of considerable size, and furnished with four longitudinal bands of muscles arranged in alternate diagonal directions, as in Fig. 9.

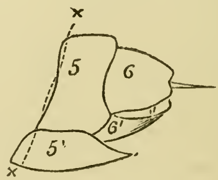
Fig. 9.



The homologues of the external sexual organs of insects present some very difficult problems, and would need a much greater general acquaintance with the subject than I can lay claim to, to render an opinion worth much. Still, if such guesses at the truth as I have to offer, should be the means of eliciting the opinions of others more qualified to judge, I shall perhaps justify their advancement. I will commence by quoting a note from Mr. B. T. Lowne's Anatomy of the Blow Fly (p. 3):—"Each segment in the lowest *Articulata* is normally furnished with two pairs of lateral appendages or rudimentary limbs, one pair placed above the other, the superior being dorsal and the inferior ventral. At least, such is their arrangement in the *Annelida*. Both pairs are much modified in the higher forms, and are often entirely suppressed. The segments themselves may be said to consist typically of four plates; a ventral, a dorsal, and a lateral plate on each side; the superior appendages being placed between the lateral and dorsal, and the inferior between the lateral and the ventral plates."

Assuming that there are nine segments in the abdomen of the Wasp, which is the number usually assigned to this portion of the body of insects, (in a species of *Stratiomys*, I think I have clearly made out ten,) six of which are apparent externally, there remain three which must enter into the composition of the sexual organs. These are enclosed within the last visible ones, as may be seen by the annexed figure (Fig. 10), where *a* represents the opening of the sexual cavity from which the sting protrudes, being covered above by the dorsal and below by the ventral plate of the sixth segment marked 6 and 6′ respectively. Now, if we make a section across the body of the insect in the line of junction of the fourth and fifth segments —viz., in the line × × in the above

Fig. 10.



figure; and, having soaked the portion thus cut off in *liquor pottassæ* and well washed it, we then view it from within in a little water, we shall, I think, see something like Fig. 11, where *5 d.* and *5 v.* are the edges of the dorsal and ventral plates of the fifth segment; *6 d.* and *6 v.* those of the sixth segment. Thus far is plain enough, and it is noticeable how the dorsal arches overlap the ventral. Within these are the sexual segments, which are more difficult to follow. The first in order is that which I have marked *7 d.*, and it is not difficult to recognise this as the seventh dorsal plate, forming as it does a distinctly continuous arch on the dorsal side, and not extending round to the ventral. Although, as I have said, distinctly continuous on the dorsum, this plate is nevertheless very narrow here, and attains its greatest breadth on each side, where a pair of spiracles are situated, below which is a suture, *ss.* (see Fig. 12), and then again another small triangular piece on each side, concerning which I am doubtful whether or not it is a portion of the corresponding ventral arch, but in either case the ventral arch of this segment cannot be traced all round.

Fig. 11.

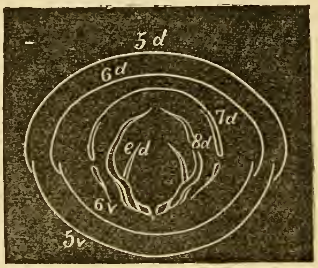
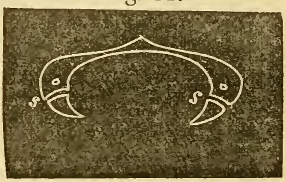


Fig. 12.



I have called attention to the narrowness of this plate in the dorsal region because I believe it indicates a transition, which is further exemplified in the two succeeding segments, by considering which we shall perhaps better understand them, for in the next or eighth segment we find the dorsal arch (marked *8d.*, Fig. 11), thinned away on its dorsal surface to a fine line, and even this vanishes quite away in the centre, while its lateral parts are considerably broadened and prolonged round towards the venter, so that it is difficult to say whether this plate is dorsal or ventral. In the last or ninth segment (marked *9 d.*, Fig. 11), the continuity of the dorsal plate on its dorsal aspect is altogether lost, while its lateral portions are so developed towards the venter (forming as they do the basal portions of the sheaths of the sting), that they might, unless carefully looked at, be mistaken for a ventral plate, for which, indeed, I at first mistook them. For the reasons mentioned, however, I regard these three plates as all dorsal. The dart evidently connects the ventral portions of the sheaths, and on this account I regard it as the ventral plate of the ninth segment; it separates the anus from the sexual opening, and is, I think, the homologue of the "curved semi-circular plate," which Mr. Lowne describes as similarly situated in the ovipositor of the Blow-Fly. The ventral plate of the eighth segment is, I believe, wanting; that of the seventh has been already referred to.

There remain now to be considered, first, two minute hairy appendages situated above and on either side of the anus; second, the terminal portions of the sheaths; and third, the spiculæ.

The first-named are found immediately behind the fine dorsal margin of the eighth segment, and appear to me to be the dorsal appendages of that segment (see Fig. 8, p. 53).

2.—The terminal portions of the sheaths are, I think, the dorsal appendages of the ninth segment; they are situated on either side of the dart just below the anus, and are homologous, I believe, with the "leaf-like appendages" of this segment in the Blow-Fly (see Lowne's Anatomy, p. 112).

3.—The spiculæ are, perhaps, more difficult to understand than any of the preceding parts, but they appear to arise from the eighth segment, and I am inclined to regard them as the ventral appendages of that segment, corresponding on the venter to those on the dorsum mentioned previously. A. HAMMOND.

Gamasus coleoptratorum.—This is a predatory acarus, found in many different situations. This, although found on the ground, is very similar to one parasitic on the House-fly. I once placed one in a test-tube with a lot of acari which I had collected, and was much disgusted to find, after the lapse of an hour or two, that it had made a meal of them. I caught it *in flagrante delicto*, for it was in the act of "putting itself outside" the last of the unfortunate acari. ALFRED ATKINSON.

Hypopus muscarum.—I once or twice have had the good fortune to capture a fly suffering from an attack of these creatures, and I am sure the poor flies were not in a state either of mind or body to gyrate very happily, and certainly not to devour their voracious tormentors as they have been said to do. It seemed to me they were in danger of being devoured themselves, so numerous were their antagonists, whilst the weight of the load they had to carry prevented them from doing more than just crawl along.

J. SARGENT, Jun.

I have found *Hypopus* upon Wire-worms very plentifully.

W. CASE.

Blood of Congo Snake.—The so-called "Congo Snake"—*Amphiuma*—is a native of North America. It is not really a snake, nor even a reptile at all, but an amphibian.

The Amphibia, which, together with the fishes, form in modern zoological classification the division *Ichthyopsida* of the Vertebrate sub-kingdom, differ from the reptiles in the possession of gills in the early stages of development, or through life; in the skin being naked instead of being covered with scales, and in several other points of anatomy and development; in all of which, except the absence of scales, they agree with the fishes. They are divided into four orders, of which one, *Labyrinthodonta*, has been extinct since the period of the Lias; and another, *Cæciliidæ*, includes only a few tropical slow-worm-like creatures. Of the other orders, that of the *Anoura*, or tailless amphibians, includes the frogs and toads; the remaining order, *Urodela*, or tailed amphibians, is divided into two sections: *Caducibranchiata*, in which—*e.g.*, our common newts—the gills disappear in mature life, respiration being carried on by the lungs alone; and *Perennibranchiata*, as the *Axolotl*, in which the gills are persistent throughout life. The latter thus permanently resemble the larva or tadpole stage of the newts. It has, however, been recently discovered that certain amphibians which ordinarily are aquatic in their habits, and retain their gills through life, breeding while in that state, nevertheless, if kept in confinement, lose their gills, and come to resemble land salamanders. *Amphiuma* is intermediate in a different way, for although its gills disappear when adult, the gill-clefts behind the head remain through life. The blood corpuscles in Amphibia are oval and nucleated; they are very large, especially in the *Perennibranchiata*, being large enough to be visible to the naked eye in several species—*e.g.*, in *Proteus anguinus*, a curious blind animal inhabiting the underground lakes in certain large caves in Austria. It is, however, in *Amphiuma* that the blood corpuscles reach the maximum size met with in any vertebrate animal, those of the Musk Deer being the smallest. The spermatozoa of *Amphiuma* are also very large and peculiar in shape; they are described and figured in, I believe, one of the numbers of the "Popular Science Review" for 1875 or 1876.

H. FRANKLIN PARSONS.

Sebaceous Glands of the Ear.—Although there are Sebaceous glands in the hair-follicles of the external meatus, the cerumen is really a secretion of *sweat-glands*. The small racemose sebaceous glands of the skin open nearly always into hair-follicles; but the follicles are in many places so small as to appear to be simply lateral involutions of the excretory duct of the gland. The "*vernix cassora*" of new-born animals represents the largest amount of this secretion.

T. W. REID.

The Sebaceous Glands are small, whitish glands, which are found over almost the whole extent of the skin, and yield a fatty secretion. Their form is very various. The simplest are pyriform or short tubular pouches, whilst in others several follicles or clusters of follicles are connected by a common duct and form a *compound racemose gland.* They principally occur in parts covered by hair, and open on the surface in conjunction with the hair-follicles. They only occur in places destitute of hair in a few special places.

The minute structure of these glands is as follows:—Every gland has an outer delicate envelope of connective tissue, which proceeds generally from the hair-follicle; within are masses of cells, which are continued from the outer root-sheath of the hair-follicle, and form a lining of rounded or polygonal, nucleated cells, disposed in several layers. These cells generally contain fat, which appears in the form of drops. They form the sebaceous matter of the skin, which at the temperate of the living body is a semi-fluid substance, but in the dead subject has more a cheesy consistence. They appear contemporaneously with the commencing hairs, or a short time after, as *outgrowths of the outer root-sheath.*

In the chest, ear, and temples, they are rosette-shaped, and measure 0·1''' in diameter. Their shape in the nose is the same, but in that organ they may measure 0·4'''.

The above is collated from "Kolliker's Manual of Human Microscopic Anatomy," in which will also be found a long list of the bibliography on the subject.

ALFRED ALLEN.

The Ear is a remarkable organ of more importance and interest than is generally supposed. *Externally* viewed, it is *alone* a more trustworthy means of identifying an individual than the whole of what are usually called "the features." One might swear confidently to a photograph of the ear of a friend, and yet say of a C. de V. portrait of him, "Good gracious! why, surely, this never could have been taken for you?"

Internally the "lute of three thousand strings" is indeed wonderful. The optic nerves (so well-known and frequently shown) take cognisance of barely an octave of luminous vibrations, but the auditory nerves embrace a range of no less than eleven octaves of sonorous ones, and yet I have never once seen a slide of *Cortis fibres* whose marvellous analytical power is such that the infinite complexity of sound-waves poured in rapid succession from a full orchestra is pleasingly and faithfully rendered as music to the brain. It is not my province to describe technically the anatomy of the ear, and could only do so by transcribing from books; but I may venture to express a decided opinion that its structure deserves more attention from microscopists, more especially now, when we are likely so soon to have an opportunity of considering the detailed mechanism of the telephone.

The following quotation so well and briefly describes the process of audition, that I trust it may be acceptable, and not considered out of place in this book. Its origin need not be sought in books, as it was written privately by a friend (J. C.) more than 20 years ago, and refers to an ear-trumpet :—

"It gathereth for me swift the rippling air
Into the Meatus auditorius
Rat-tat, it beats the quivering Tympanum,
Whereat the Malleus to the Incus speaks,
The Incus to the Os orbicular,
This to the Stapes—which directly knocks
At the two windows, oval and rotund ;
Within the which, intently listening, couch
With eager ear the merry Auditors.
Who follows farther must be more than man."
Etc. etc.

W. TEASDALE.

Reviews.

STUDIES IN MICROSCOPICAL SCIENCE. Edited by Arthur C. Cole, F.R.M.S.

We are very pleased to receive a parcel of Mr. A. C. Cole's series of "Studies," and heartily congratulate him on the success of his undertaking.

On the present occasion we can only afford space to notice his Petrological and Botanical series. Of the former, four parts have been issued. No. 6 contains a very beautifully coloured lithographic plate of Pikrite, and 6a has an Analytical Chart of the same ; 26 consists of six representations of Dolerite, and 36 contains a plate of Diabase. In the letterpress each subject is treated in a thoroughly exhaustive manner; the Etymology being in all cases given in addition to a lengthy description. Methods of Preparation, Mounting, etc., are given, to which is added a long list of the Bibliography on the various subjects.

The Botanical subjects already treated of are—T.S. of Dicotyledonous Stem, the example being Copper Beech, followed by a T.S. of Monocotyledonous Stem, *Cyperus Alternifolius;* T.S. Rachis of Bracken Fern; T.S. Thallus *Fucus vesiculosus;* the plate also shows Antheridia and Oogonia; T.V.S. of Leaf *Rhododendron Ponticum;* V.S. Cluster Cups of Coltsfoot; T.S. Aerial Stem of *Equisetum arvense;* T.S. Root of *Taraxacum officinale*, with which two plates are given, one showing position of Xylem, the other, portion of Bast and Cambium; T.S. Stem *Lycopodium Wildenovii;* T.S. Stem *Pilularia Globulifera;* T.S. Sporocap of the same; T.S. Thallus of Lichen, *Sticta Palmonacea;* T.S. Thallus *Sticta aurata;* T.S. Stem of *Juncus Communis* var. *effusus;* L.S. Stem *Euphorbia splendens.*

In looking through the above our pleasure increased with each successive issue of the "Studies"—a title which they richly merit. The whole work is, in our opinion, most studiously, carefully, and conscientiously carried out. Each subject is handled in a thorough and masterly manner, and every information possible to be obtained on the subjects treated, will, we think, be found here. We cordially recommend our readers to subscribe to these studies.

The Microscopical News and Northern Microscopist. Edited by George E. Davis, F.R.M.S., F.I.C., F.C.S., etc. (*David Bogue, London.*)—Part 1 of Vol. 3 of our old friend the "Northern Microscopist," under its new title, is to hand. It contains 28 pages of very interesting matter. Amongst other papers we are pleased with that on the Orange Coccus, which is well illustrated; on Moss Development (to be continued), also illustrated; and on the Diagnosis of Blood-Stains.

We think our contemporary has begun the year well. Mr. Davis calls special attention to his change of address, which is now "The Willows, Fallowfield, Manchester."

Foraminifera.—Mr. F. P. Balkwill, 90, Marlborough Road, Dublin, has sent us one of his excellently-mounted slides, containing 50 species. The objects are mounted on a glass slide, 3 in. by 1½ in., with black back-ground, divided into 50 compartments, each square containing several representatives of the same species shown in different aspects.

The names are plainly printed in white letters under each species. The following genera are represented :—

Cornuspira, 1 sp	Biloculina, 2 sp.	Trochammina, 1 sp.
Miliolina, 6 sp.	Haplophragmium, 2 sp.	Lagena, 14 sp.
Nodosaria, 2 sp.	Dentalina, 1 sp.	Cristellaria, 1 sp.
Polymorphina, 2 sp.	Globigerina, 1 sp.	Textularia, 1 sp.
Verneuilina, 1 sp.	Bulimina, 4 sp.	Bolivina, 2 sp.
Discorbina, 2 sp.	Planorbulina, 1 sp.	Truncatulina, 1 sp.
Rotalia, 2 sp.	Polystomella, 2 sp.	Nonionina, 1 sp.

THE AMERICAN NATURALIST. (*Philadelphia: McCalla & Staveley.*)—We have just received the 12 monthly parts forming the 16th annual volume of this most interesting Journal. It contains 1057 pages, 16 lithographic plates, and a great number of engravings. On a careful perusal of this journal we find it to be all that its title claims for it, viz., a " Naturalist, devoted to the Natural Sciences in their widest sense."

Each part contains a number of carefully written articles, amongst which we notice—" The Blind Cave-Fishes and their Allies ;" " A Parasitic Isopod Crustacean, and some of its developmental stages ;" " The Heterogeny of *Oxalis Violacea ;*" " Forests, their influence upon Climate and Rainfall ;" " The Tertiary Formations of the Central Region of the United States ;" etc. etc. The articles are all well written, and exceedingly interesting. In addition to which in each number are to be found departments devoted to Recent Literature, Botany, Zoology, Entomology, Anthropology, Geology, Paleontology, and Mineralogy, Geography and Exploration, and last but not least, Microscopy. In memory of the late Charles Darwin, the part for June is devoted in a great measure to articles on Evolution. Amongst other papers we were particularly interested with that on the " Transformations of *Planorbis* at Steinheim, with remarks on the effects of gravity upon the forms of shells and animals" ; this paper is illustrated with two plates.

The "American Naturalist" is edited by Messrs. A. S. Packard, jun., and Edward D. Cope, assisted by several other eminent men, and is unquestionably a journal in which the Scientist, no matter what his special branch of Science may be, will be sure to find something relating to his own particular pursuit, and we have much pleasure in cordially recommending it to our readers.

MICROSCOPICAL DIAGNOSIS, 1882, by Chas. H. Stowell, M.D., and Louisa Reed Stowell, M.S. (*Geo. S. Davis, Detroit, U.S.A.*)—Consists of a series of Papers on a variety of subjects interesting to microscopists. The work is divided into three parts. The first part consists of a long chapter on the Microscope and its various appliances, explaining their various uses; to which is added formulæ for the preparation of media used in hardening and cutting sections, more especially of such as would come under the notice of the medical student, and is followed by others on the Blood, Muscle, Urinary Deposits, Parasitic Diseases of the Skin, Tumours, Starch, and the Staining of Blood. The chapters on Urinary deposits are well written, and particularly well illustrated by 8 lithographic plates, beautifully drawn by Mrs. Stowell.

Part 2 is devoted to Botanical Histology by Mrs. Stowell, the subjects treated of being of general economic or medicinal importance, the question of adulteration and means of detection being by no means overlooked. We have particularly noticed that portion which treats of Wheat; the numerous woodcuts illustrating this portion of the work render it unusually interesting and valuable.

We scarcely see why Part 3 should form a separate section of the work; it consists of hints on the Preparation and Mounting of Microscopic objects, and would, we think, have formed a suitable continuation of Part 1; we notice, however, that they are written by Mr. W. H. Warmley, and are reprinted from the "Microscope." It contains a series of very instructive and popular papers, and forms a good appendix to the entire work. The vol. contains about 240 pages, 10 lithographic plates, and a number of wood engravings.

THE STUDENTS' MANUAL OF HISTOLOGY, for use of Students, Practitioners, and Microscopists. Second Edition, 1882. By Chas. H. Stowell, M.D. (*Geo. S. Davis, Detroit, U.S.A.*)—The fact that the first edition of this excellent work should have been sold out within a year, speaks well for its usefulness.

In common with most works of its kind the first chapter, a short one, treats of the Microscope and its various accessories, and is followed by others on the Amœba and the cell-blood; Epithelium and Hair; Connective Tissue; Teeth; Muscle; Blood-vessels; Respiratory Passages; Salivary Glands; Pharynx; Œsophagus, Stomach, etc.; Liver; Kidney; Spinal Cord; Brain; Eye; etc. etc., and concludes with a paper on Starches. The subjects throughout are cleverly treated, and we think the book is deserving a place in the library of every medical student and practitioner. It consists of about 300 pages and 192 wood-engravings.

Mr. W. P. Collins' Catalogue of Scientific Books.—Part 10 is to hand, and comprises a number of valuable and rare works. It is divided into two sections. The first relates to Microscopy and the allied sciences, and in addition to second-hand books, gives a list of Journals and Transactions of Microscopical Societies, etc., in course of issue. Part 2 is devoted more particularly to works on Biology, Botany, Chemistry, Conchology, Electricity, Entomology, Evolution, Geology, Mineralogy, Natural History, Palæontology, etc. Book-buyers would do well to write to Mr. Collins, 157, Gt. Portland Street, London, W., for this catalogue.

The Detroit Lancet, No. 201, December 1882, a monthly exponent of Rational Medicine. Edited by Leartus Connor, A.M., M.D. (*Geo. S. Davis, Detroit, Mich., U.S.A.*)

The Therapeutic Gazette, Vol. 6, No. 10, a monthly Journal devoted to the Science of Pharmacology, and to the introduction of New Therapeutic Agents. Edited by Wm. Brodie, M.D., and F. E. Stewart, Ph.G., M.D. (*Geo. E. Davis, Detroit, Mich., U.S.A.*)

The Michigan Medical News, Vol. 5, No. 22, a Journal devoted to practical medicine. J. J. Mulheron, M.D., Editor and Publisher, Detroit.

The Detroit Clinic, Vol. 1, No. 49, a weekly exponent of Clinical Medicine and Surgery. Edited by H. O. Walker, M.D., assisted by H. Erichsen, M.D. (*Geo. S. Davis, Detroit, Mich., U.S.A.*)

The above are Medical Journals published at Detroit, America. The "Lancet" consists of 48 pages, and embraces papers on a variety of subjects—fevers, insanity, etc. We notice also an excellent paper on the Power of Alcohol over the nature of man, as displayed in the Mind, Morals, and Physical Condition, incident to its use.

The purpose of the "Therapeutic Gazette" is said to be, to devote that especial attention to Pharmacology which this department of medicine does not receive from any other of the American Journals, and to be the means through which the profession may become familiar with the more recent additions to the Materia Medica. It contains 40 pages, is well printed and got up, and is said to have the largest sale of any medical work in

America. The subjects treated of are divided into various departments, *e.g.*, New Remedies from Private Practice, Transactions, Correspondence, etc. etc.

The "Clinic" and "Medical News" are both published weekly, at a dollar per annum. We should think that the small price of one penny a week would bring them within the means of the medical student or practitioner of even a limited income.

MISCELLANY OF MICROSCOPIC ILLUSTRATIONS. By E. Wade-Wilton, of Leeds.—We have received a forward copy of the first issue of this work. The Miscellany will commence in June, and be continued Monthly. The Illustrations, which are exceedingly well executed, are from copper plates, and are, with the descriptions, printed by lithography on good plate paper. They will doubtless prove a valuable help to the student of Pond Life.

Current Notices and Memoranda.

The Asparagus-Stem for Laboratory Study.—"This plant affords as interesting and instructive an example of the stem of Monocotyledons, as the now generally used Pumpkin-stem does of the Dicotyledons. It is so common that every botanical laboratory can be supplied with it, and its early appearance, and long-continued growth, make it possible to secure fresh specimens during many months of the year. The new shoots, such as are sold in the markets, if placed in alcohol, afford good material for study, although we have found it a better plan to make all the sections we wanted of fresh stems, and then to preserve these sections in alcohol. Thus, some cross and longitudinal sections of the young stems we made early last year, are still in most excellent condition for study. Not the least interesting feature of the Asparagus-stem is its provision for increasing its diameter by the subsequent formation of fibro-vascular bundles in a sub-cortical meristem zone. This will afford material for much careful study on the part of students in the laboratory."

American Naturalist.

Exchange.—I offer **Fossil Diatoms** from Franzenbad, in Bohemia, and from Celle, in Hanover (any quantity), in exchange for good Micro-material or Mounted Slides.

J. C. RINNBÖCK,

14, Simmering, near Vienna, Austria.

The Journal

OF THE

Postal Microscopical Society.

JULY, 1883.

The Application of the Microscope to Geological Research.

By Mrs. A. Cowen.

THOUGH the microscope has long been employed in investigations in the growth and development of the lower forms of animal and of vegetable life, as well as in the minute structure of the higher forms, it is only within a comparatively recent period that it has been brought into use by the geological inquirer. In this field a vast amount of information is afforded by its means, not only with regard to the minute characters of the many animal and vegetable remains which are entombed in the successive strata, of which the crust of the earth is composed, but also with regard to the essential nature and composition of many of those strata themselves.

The first who conceived the idea of cutting minerals in thin transparent slices for microscopic examination was Nicol, the inventor of the polarising instrument which bears his name. This was in 1827, and in 1831 his friend, the botanist Witham, studied by this means silicified wood, and proved, to the great astonishment of the learned world, that these stony matters preserved, in their smallest detail, the structure of the organised body to which they owed their origin.

In 1840, M. A. Brongniart followed up these investigations and examined many varieties of fossil wood.

From these and other observations we learn that, generally speaking, the lignites or fossil wood of the Tertiary strata present a tolerably close resemblance to the wood of the present day. Thus the ordinary structure of the dicotyledonous and monocotyledonous stems may be discovered in such lignites in the greatest perfection, and the peculiar modification presented by Coniferous wood is also most distinctly exhibited.

As we descend through the strata of the secondary period, we meet more and more rarely with the ordinary dicotyledonous structure, and the lignites of the earliest deposits of these series are generally either gymnosperms or palms.

Descending into the Palæozoic series, we are presented in the vast coal formations with an extraordinary proof of the prevalence of a most luxuriant vegetation in a comparatively early period of the world's history, and the microscope lends the geologist essential assistance, not only in determining the nature of much of that vegetation, but also in demonstrating that coal itself is nothing else than a mass of decomposed vegetable matter, derived from the decay of an ancient vegetation. The determination of the characters of the Ferns, Sigillariæ, Lepidodendra, Calamites, etc., whose forms are preserved in the shales which are interposed between the coal strata, has generally been based on their external characters, as it is seldom the internal structure is well enough preserved for microscopical examination, but recently coal-plants have been found in a better state of preservation, whose internal structure has been studied microscopically; and the careful researches of Professor Williamson have shown that they formed a series of connecting links between the Cryptogamia and flowering plants, being allied to the *Equisetaceæ* and *Lycopodiaceæ*, etc., in the character of their fructification, whilst their stem structure foreshadowed both the endogenous and exogenous types of the latter. Even in the coal itself, which presents the appearance of a structureless mass of black carbonaceous matter, there are found a multitude of minute, resinoid, yellowish-brown granules, which are sometimes aggregated in clusters and enclosed in sacculi. These may be taken to represent the spores, while the sacculi represent the sporangia, of gigantic Club-mosses of the Carboniferous flora.

Passing on now to the animal kingdom, we find that as early as 1836, Ehrenberg had discovered that large rock-masses were built up of the siliceous shells of minute organisms, classed by him among the Infusoria, but now referred to the Algæ under the name of Diatoms, and since that time Mr. Sorby has done good service by his investigation of limestones; these he has proved, for the most part, not to have originally possessed any crystalline structure whatsoever, but to have been deposited as mere mechanical aggregates of organic sands or clays, formed of the *débris* of calcareous organisms of which the individuals can be recognised.

The comparison of the microscopic structure of the organisms in chalk with those now found in the depths of the North Atlantic Ocean, indicates that an immense deposit is now in course of formation, quite analogous to what had previously taken place in the seas of the Cretaceous period. A large proportion of the North Atlantic sea-bed is found to be covered with an ooze, chiefly formed by the shells of *Globigerinæ,* and this not a mere surface-film, but an enormous mass, as proved by the large quantities brought up by the dredge.

Sir Wyville Thompson thus describes a sample of one and a-half hundred-weight, obtained from a depth of nearly three miles: "Under the microscope, the surface-layer was found to consist chiefly of entire shells of *Globigerina bulloides*, large and small, and of fragments of such shells mixed with a quantity of amorphous calcareous matter in fine particles, a little fine sand, and many spicules, portions of spicules, and shells of *Radiolaria*, a few spicules of sponges, and a few frustules of diatoms. Below the surface-layer, the sediment becomes gradually more compact; and a slight grey colour, due probably to the decomposing organic matter, becomes more pronounced, while perfect shells of *Globigerina* almost disappear, the fragments become smaller, and calcareous mud, structureless, and in a fine state of division, is in a greatly preponderating proportion. One can have no doubt, on examining this sediment, that it is formed, in the main, by the accumulation and disintegration of the shells of *Globigerina*, the shells, fresh, whole, and living in the surface-layer of the deposit, and in the lower layers dead, and gradually crumbling down by the decomposition of their organic cement, and by the pressure of the layers above."

Now, the resemblance which this Globigerina-mud, when dried, bears to chalk is so close, as to suggest a similar origin of the latter, and this is at once confirmed by microscopic observation. Many samples of it consist, in great part, of the minuter kinds of Foraminifera, especially *Globigerinæ*, whose shells are embedded in a mass of apparently amorphous particles, many of which nevertheless present indications of being the worn fragments of similar shells or of larger calcareous organisms; whilst in other places, the chief part is made up of the shells of Entomostracous Crustaceans. And, further, the Globigerina-mud now in process of formation is in some places crowded with sponges, having a siliceous skeleton, and some of these bear such an extraordinary resemblance in structure and in internal form to the Ventriculites, which are well known as Chalk fossils, as to leave no reasonable doubt that these also lived as sponges on the bottom of the Cretaceous sea. Other sponges, also, are found in the Globigerina-mud, the structure of whose horny skeleton corresponds so closely with the sponge-tissues, which can be recognised in sections of nodular flints, as to make it clear, when taken in connection with the correspondence of external form, that such flints are really fossilised sponges, the silicifying material having been furnished by the solution of the skeletons of the siliceous sponges, or of Diatoms or *Radiolaria*.

There are other deposits of less extent and importance than the great chalk formation, which, like it, are composed of microscopic organisms, chiefly Foraminifera, and the presence of animals of this group may be recognised by the assistance of the microscope, in sections of calcareous rocks of various dates, whose chief materials seem to have been derived from Corals, Encrinite stems, or the shells of Molluscs, as in the Crag formation of the Eastern coast of England.

Many parts of the Oolitic formation have an almost identical character, except that the forms of organic life give evidence of a different age, whilst in those portions which exhibit the "roe-stone" arrangement, from which the rock derives its name, as in some Bath and Portland stones, it is found, by the microscopical examination of transparent sections, that each rounded concretion is composed of a series of concentric spheres, enclosing a central nucleus, which nucleus is often a Foraminiferal shell.

The application of the microscope to geology is not, however, limited to the determination or discovery of organic structure; very important information may be obtained by its means respecting the mineral composition of rocks and the mode of their formation, and it is specially in the study of the Eruptive rocks that this method of observation is most valuable. Very little comparatively had been done in England on this subject till quite a recent period, when Messrs. Sorby, Allport, and others turned their attention to it, and did some most valuable work in microscopic geology.

In 1858, Mr. Sorby brought out his celebrated paper on the "Microscopic Structure of Crystals" in the *Quarterly Journal of the Geological Society*, in which he describes the glass, stone, and gas or vapour cavities in the minerals of the pitchstones of Arran, the lavas of Vesuvius, and some of the basaltic rocks of Scotland, as well as in the quartz of granites, and thence draws conclusions respecting the common origin of these rocks.

In 1867, an article appeared upon the "Microscope in Geology" in the *Popular Science Review*, written by Mr. David Forbes. The author draws attention to Mr. Sorby's discoveries, and shows how the different minerals in volcanic rocks may be distinguished from each other by means of the microscope, and gives figures illustrating the microscopic structure of various rocks.

The first of a series of valuable papers by Mr. Allport appeared in 1869 in the *Geological Magazine*, describing the basalt of South Staffordshire, and others followed on the "Basaltic Rocks of the Midland Coal-Fields," "The Microscopical Examination of Rocks and Minerals," etc. etc., the author arriving at the conclusion that there is no essential difference between the eruptive rocks of different geological epochs.

A very complete account of the rocks of the Lake district of

England is given by the late Rev. J. Clifton Ward in the "Survey Memoir," as well as in other papers in the *Quart. Journal Geol. Soc.*

Professors Hull, Bonney, and others have also contributed to the literature on the subject in the different geological magazines, as well as Mr. Rutley, of the Geological Survey, who has also published a useful treatise on "The Study of Rocks."

More has been done in Germany than in England in this branch of science, and amongst a number of others I may mention the names of Vom Rath, Zirkel, Vogelsang, and Rosenbusch, who since 1860 have published numerous works upon the subject.

Amongst the workers in France we find the names of Descloizeaux and Messrs. Lévy et Fouquet; the memoir by the latter gentlemen on "Minéralogie Micrographique," descriptive of the eruptive rocks of France, is a splendid work, published by the French Government, accompanied by a set of beautifully coloured plates, illustrating the minerals described.

The value of the method of examination of rocks by means of thin sections is at once evident, when we have at hand specimens which appear so exactly alike, that it is difficult to distinguish between them, though they may have come from totally different rocks; as, for example, a fine-grained grit and a volcanic ash. The rounded grains of the first show under the microscope its sedimentary origin; while the unworn, prismatic, crystalline structure of the other proves that it is not a sedimentary rock.

The discovery by Sorby of the numerous minute fluid cavities in the quartz of granites shows the great value of the microscope in the study of these rocks, as it proved that granites have solidified at a heat far below the fusing points of their constituent minerals, and at such a pressure as to enable them to entangle and retain a small amount of aqueous vapour, which naturally must have been present during liquefaction. The presence of similar fluid cavities, not only in the quartz of volcanic rocks, but also in the felspar and nepheline ejected from the crater of Vesuvius at the present day, led him to class them as rocks of similar origin.

When, as is often the case, especially with colourless minerals

—like quartz, leucite, felspar, etc.—the appearance presented under the microscope is alike, their optical properties and the use of polarised light afford the means of distinguishing between them with certainty; as also in the event of one substance being present under two forms, as calcite from arragonite, monoclinic from triclinic felspars, etc., and, in a similar manner, the structure, whether crystalline or vitreous, is determined, and valuable information gained, elucidating the mode of formation and origin of the rocks themselves.

For the purpose of investigating the optical properties of minerals, various instruments have been devised. The apparatus most commonly employed with microscopes consists of two Nicol's prisms—one fitted beneath the stage of the microsope, and the other, either above the eye-piece of the instrument or above the objective, the lower one acting as the polariser, the upper one as the analyser; both polariser and analyser ought to be capable of rotation. It is also necessary that there should be some means of rotating the section itself between the Nicols, in order to ascertain whether it is dichroic or not.

A description of a few of the most important minerals which enter into the composition of the eruptive rocks may not be uninteresting. Felspars usually occur in long, prismatic crystals. They are divided into two groups, according to the system under which they crystallise—Orthoclase, in which the chief cleavages are situated at right angles to each other; Plagioclase, in which the cleavage planes do not intersect at right angles. These two groups may, in most cases, be distinguished under polarised light by the differences they possess in their twinning, crystals of orthoclase and its varieties usually showing, when twinned, a median divisional plane, on either side of which the halves of the crystal depolarise the light in complementary colours; whilst in the case of plagioclase, the crystals exhibit numerous bands of different colours.

Sections of Quartz appear clear and pellucid under the microscope; they show circular polarisation, and often exhibit magnificent variegations of colour. Quartz often contains fluid cavities, and sometimes contains bubbles of gas.

Augite often occurs in dolerites and basalts in well-formed crystals. The colour, in ordinary transmitted light, varies from a dark purple-brown to a pale brownish-yellow; they are transparent, and exhibit fine colours under polarised light. Hornblende is the only mineral likely to be mistaken for Augite. The form of the crystals is slightly different, and it is distinctly dichroic, which Augite is not.

Olivine, in very thin sections, under the microscope, appears almost colourless, and of a light greenish tint in those of moderate thickness; it polarises in tolerably strong colours, red and green, but not so brilliant as those displayed by quartz. The surfaces of Olivine are nearly always rough, since the ordinary grinding is never capable of imparting a smooth polished face to the section. It is frequently altered into serpentine.

Mica varies in colour from silvery white to almost black, according to the kind. One of the most common forms in dolerites is Biotite, which is black or dark-green, frequently occurring in irregular polygonal plates or narrow strips, containing well-marked parallel lines. The colour varies under polarisation from pale brown to dark opaque-brown, or nearly black.

Magnetite occurs in black grains, which are quite opaque in the thinnest sections. The most frequent crystalline form is the octahedron, its section being a black square.

Granites, dolerites, and basalts, are chiefly made up of some of these minerals in varying proportions.

In the foregoing brief historical sketch of the application of the microscope to geological investigation, and the indication of the several lines on which that investigation has been carried on, it has been my object to show how interesting the study of microscopic geology may be, even to amateurs, who have neither the time nor the knowledge to enter into original researches concerning the conditions under which our rocks have been formed, but who will thus be able better to appreciate the work, and accept intelligently the conclusions of those scientific men who have devoted themselves to the elucidation of these subjects.

On the Palpi of Fresh-Water Mites as Aids to distinguishing Sub-Families.

By C. F. George, M.R.C.S., Lon., etc.

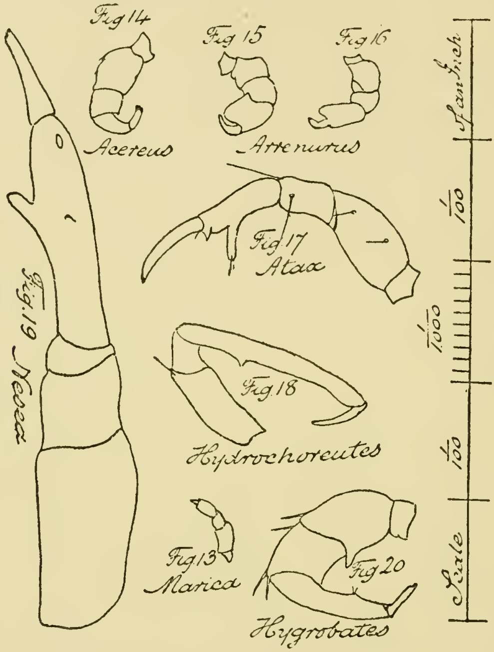
ALL entomologists have observed the wonderful modifications which occur in the same organ in different insects, and so well is this known, that it has more than once formed the basis of classification; it is, however, unreasonable to suppose that the examination of a single organ should be sufficient to enable the most learned to identify any and every species not previously seen by him. Nevertheless, when applied to small circles, this knowledge of the variation of certain organs may be of the greatest use in identifying "groups," even though it entirely fails to distinguish individuals. In studying the fresh-water mites, I have been struck with the variation to be found in the palpus of each sub-family. This organ only consists of five joints, and readily admits of examination under the microscope even whilst the creature is alive, as, for the most part, it is alternately extended and flexed when the mite is in confinement, in its endeavour to escape, and a very cursory examination will frequently enable the observer to pronounce at once, in which sub-family the creature is to be placed. I thought, therefore, that a few sketches of the palpi, from specimens found by myself, would be of interest to the readers of this Journal, and more particularly to those who are members of the "P.M.S.," in whose boxes I have placed specimens of these mites, and intend, should circumstances permit, to continue to do so, when my turn for changing slides shall come round. The fresh-water mites are divided into three families :—

1.—**Flussmilben.**
2.—**Weihermilben.**
3.—**Sumpfmilben.**

It is the first family—Flussmilben—Hygrobatides, or river-mites,—I intend to illustrate on this occasion; perhaps at some future time I may deal with the other families.

Fig. 13 represents the palpus of the extremely curious mite called *Marica Musculus.* Here there does not seem much to observe, the organ being very simple. It will be seen that the second and fourth joints are the longest, and the fifth claw-shaped.

In Fig. 14 we have not much difference; the second joint is, however, very much broader and flattened, and the fourth narrower.



Palpi of Hygrobatides

In Fig. 15 and Fig. 16 the fourth joint is differently formed, being much broader, and having one angle lengthened, so as to form with the very movable fifth joint a pair of forceps, reminding one of the large claw of a crab, or the beak of a parrot.

In Fig. 17 we find a very large and curious process growing from the outside of the fourth joint.

In Fig. 18, *Hydrochoreutes*, we have the fourth joint elongated so much that it is longer than the second and third joints together. In this figure and Fig. 19, *Nesea*, the first joint is not represented. In this last there is also a projection on the outside of the fourth joint. This, however, is not present in all species of *Nesea*, and when it is, it is altogether insignificant compared with the one on the fourth joint of *Atax*.

In Fig. 20, *Hygrobates*, there will be perceived a projection on the second joint, which is altogether absent in any of the other figures; a careful study of these figures will, I think, be a great help to the student commencing the study of the *Hygrobatides*.

A Day's Microscopic Shore-Hunting among the Low-Tide Pools of Jersey.

By Edward Lovett.

IT is of great importance to study the living appearance and surroundings of any subject of investigation, as errors are frequently made and false conclusions arrived at, when we have only the dead specimen before us, and knownothing of its proper *habitat*, or of its appearance when in the full vigour of life. This being the case, all microscopic naturalists should endeavour to do some practical collecting occasionally, in whatever branch of study they may be working, for although it is often much sterner work than is generally supposed, still it is of great value, not only for the reasons already given, but also as supplying a recreation, beneficial alike to mind and body.

Few spots are more favourable for shore-hunting, or richer in specimens of marine zoology, than the coasts of the Channel Islands; specimens which are of great rarity on our own shores are often abundant here, and in some favoured nooks the quantity of life is marvellous.

Jersey is chiefly composed of Syenites, Basalts, Diorites, etc. Many parts of its coast-line are high and precipitous, especially in the northern part of the island; towards the French coast, however, it is comparatively low and shelving, so that at low water many thousand acres of rock are uncovered, whereas in the former the base of the Syenite cliff is never exposed.

Having thus briefly introduced the subject, let us endeavour to imagine ourselves about to start for a day's real practical collecting amongst the low pools. It is an extra low tide, on one of the most charming mornings in May that it is possible to imagine,—there is just enough breeze to make it agreeable and not sufficient to ruffle the surface of the pools, and prevent our examination of the bottom. It will be low water to-day at two o'clock p.m., and as it would be highly dangerous, owing to the rapid flow and deep intersecting channels, to be down at the water's edge at that time without a boat, we will start with the ebb and follow it down, working as we go.

[I must here mention that it would be the height of folly to work this coast, St. Clement's Bay, unless accompanied by some one who knows the tide and the place well, as the risk of being cut off is very great.]

Our outfit consists of a good pair of sea-boots, and clothes that it does not matter about soiling; our apparatus a square handled basket containing a box and a couple of jars, also a case of tubes of fluid; a small hand-net of cheese-cloth, and a pair of forceps.

Having arrived at the shore, we find the tide receding fast, and a few rocks already exposed to view. It is agreeable to see that the rocks here are not covered with dense masses of "wrack," which is very advantageous, as we are much better able to examine them or to turn them over; in doing which we find a few *Ophiocoma neglecta*, which we transfer to a fluid-tube. But we must proceed, for across this Channel, down which the water is flowing sea-wards like a mill-race, a reef of rugged rocks is exposed, crusted over with *Balanus* and many shells, such as *Purpura lapillus*, and two or three species of *Littorina*, a few of which, for the purpose of securing their palates, we will put into our box with some algæ. The gelatinous-looking mass attached to this rock is a group of ova of one of the Nudibranch molluscs, probably *Doris* or *Eolis*. Ah! it is the latter, for here is a specimen of *Eolis papillosa* close by. Under the microscope, this glairy matrix is seen to contain minute eggs, and as they approach maturity the young *Eolides* can be defined. We will now turn this big piece of Syenite over, and what a sight meets our view! Four species of Crustacea in one hollow *Xantho florida* with a large bunch of ova, *Porcellana platycheles*, *Cancer pagurus*, and a host of *Athanas nitescens*, to say nothing of many sessile-eyed forms, as *Gammarus*, etc. The ova of *Xantho florida* are very beautiful under the microscope; their colour is a rich golden, and the minute threads attaching each ovum to the main stem, which is connected with the basal joint of the swimmeret, are very curious. *Porcellana platycheles* is a remarkable crustacean; its flat little carapace and broad claws enabling it to lie closely to the surface of the encrusted rock, we hardly know at first whether it is a crab, or only a bit of the rock itself. When very young, this is a most interesting object for the microscope. Its claws are beautifully fringed with cilia, and its compound eyes, plumose antennæ, and remarkable limbs, make it altogether a curious little fellow. *Athanas nitescens*, although barely an inch in length, of the Macrura or lobster form, is much more advanced in that type than even its larger ally, the prawn, for its first pair of legs are quite stout little pincers, as large in proportion as those of the lobster.

Whilst we have been examining this overturned rock, the tide has gone down considerably, and we are able to advance half-a-mile or so, wading several channels, and crossing several masses of pointed rocks, until we come to a reef in which there is a large lagoon or pool, probably covering an extent of a couple of acres. All around are grey pinnacles of rock; the bottom of the pool is white with the triturated fragments of shells, relieved here and there with patches of deep green *Zostera*.

Gobies, Bull-heads, Wrasse, and other fish, dart out from shelter as we disturb the luxuriant masses of brilliantly-coloured algæ, for by working our hand-net slowly round this algæ-fringed pool, a number of interesting forms are obtained, *Palæmon squilla*, one of the prawns, with its almost transparent carapace, being conspicuous on account of its vivacious habits.

The Goby and Wrasse have spawned some time, so most probably we shall find their eggs if we look carefully. We have not long to search, for the silvery little patch on this rock, just washed by the ripple of the receding tide, is a group of ova of the Goby. If we examine it closely, we shall see that each egg, which is cigar-shaped, but pointed at both ends, is attached to the rock by one of its points, so that the whole mass of eggs is packed together on end in this manner. The young, just ready to emerge, are alive and wriggling about inside the egg-cases; and the silvery appearance which attracted our attention, is nothing more than the brilliant sparkle of thousands of pairs of little eyes. We will scrape off a portion, and transfer it to one of our tubes for microscopic examination, and shall thus be able to see the tail, fins, pigment-cells, and structure generally of the minute fish wrapped in its tiny case, barely an eighth of an inch in length.

In this hole is the nest of a Wrasse, formed of about a peck of algæ stowed away in an untidy fashion, the eggs being mixed up with it. What a difference between the two fishes! The one fixes its long, pointed eggs to the surface of a rock, whilst the other, whose eggs by the way are quite round, packs them away in a hole with a lot of sea-weed. The eggs of the Wrasse are, however, very interesting, as, with our microscope, the young may be seen coiled up in its egg-case, much in the same way as the Zoæa of Crustacea.

As we examine the *Zostera*, we notice some curious little bodies on the fronds. These are the egg-capsules of one of the Mollusca, *Nassa incrassata*, placed in regular rows; they are flask-shaped and flat, the mouth, from which the young escape, being at the top. They form most beautiful microscopic objects.

It is surprising what a quantity of *Aplysias* we find here. Their ova will be found in dense masses of a brilliant yellow or red colour, in long strings of a gelatinous substance, and are most curious.

But suddenly a curious and warning phenomenon meets our view. All this time, during the ebb, the long wavy fronds of the *Zostera* have been pointing sea-wards, but, as we watch, we notice that the points are curving over, and we well know that in a short time the fronds washed by the rapidly-rising tide will be all pointing land-wards, and we also know that it is time to beat a hasty retreat from these almost tropically luxuriant pools. As we near the margin of the rising tide, we are much struck with the number of prawns foraging along the newly-covered shingle for any "refuse" that may have dropped there since last tide.

We have now been down among the rocks for several hours, and have collected enough material to supply us with interesting work for several months, and learned such lessons out of Nature's own book, as may afford us subjects of thought for a lifetime; and as we leave behind us the charming scenes of one of the happiest days it has been our fortune to enjoy, we can only hope that every member of the "Postal Microscopical Society" may be induced to follow our example with the same beneficial results.

The Fly.

By Fredk. Fitch, F.R.M.S., F.G.S., etc.

Plate 26.

THE Fly belongs, strictly speaking, to the order Diptera, but the word, as commonly employed, is incorrectly given to many insects belonging to other orders. Thus, the May-fly and Dragon-fly are of the order Neuroptera; the Fire-fly and Turnip-fly are, in fact, beetles, and of the order Coleoptera; the Green-fly and Snowy-fly are Hemiptera; while the Oak Gall-fly, Marble Gall-fly, Saw-fly, and Ruby-tail fly are, like bees, belonging to Hymenoptera. But there are also the Onion-fly, Carrot-fly, Cabbage-fly, Crane-fly, Hessian-fly, Bot-fly, Gad-fly, Forest-fly, Drone-fly, Snout-fly, Blue-bottle fly, and Blow-fly, which are all allied species, and come under the general term Diptera—a word first employed by Aristotle twenty-two centuries ago, to describe those insects which have two wings only.

The order is an immense one. In species and individuals, it far outnumbers any other order in creation. It is estimated that there are 4,000 different genera, comprising 20,000 species. They are besides very widely distributed, having been found in high latitudes, where they are few and feeble; in temperate climates, where they abound; and in tropical climates, where the most highly developed species are found, and where, too, they exist in still greater abundance.

One author observes :—" To a geographical distribution of the widest extent, the flies add a range of habits of the most diversified nature; they are both animal and vegetable feeders, an enormous number of their species acting as scavengers in consuming putrescent and decomposing matter of both kinds. Many are parasitic."

The same author observes :—" Considered in relation to man, there would seem to be sufficient reason for placing this apparently feeble order at the head of our insect enemies. Allowing for the good effected by the clearing away of animal and vegetable impurities by many species, and for the indirect advantage caused by the known instances of a few others assisting in the fecundation of plants, there remains a long list of direct injuries effected by *Diptera*. Without laying undue stress upon the formation of galls and other vegetable deteriorations caused by many species, there can be no doubt that the destruction of grass-lands by the larva of the Crane-fly, or Daddy Long-legs, *Tipula oleracea*, of olive-crops by *Dacus*, of oranges by *Ceratitis*, of various culinary plants by others, and of wheat and other crops by the Hessian-fly, are of very serious consequence. Our domestic animals, moreover, suffer from the Bot-fly, the Tick, and the Gad-fly. Still more dreaded is the Tsetse-fly, *Glossina morsitans*, which is of sufficient power to prevent the exploration of a region in which it occurs. Nor is man himself spared. The petty inconveniences of wasted food, broken rest, and slight personal pain, experienced in temperate regions from fly-larvæ, gnats, midges, etc., are aggravated in both warmer and more boreal countries to a dangerous extent, and have been even found prejudicial to life. One of the flies, *Lucilia hominovorax*, is known to have caused considerable destruction to human life among French convicts in Cayenne, by laying its eggs in the mouth or nostrils during sleep."

As to annoyance, most of us have had our own experience. We have felt the venom of the Gnat, and perhaps of the Gad-fly. In the warm summer, swarms of flies settle on the heads of horses and cows. They creep into the eyes and ears of these animals, in order to feast upon the humours there secreted. This fly—a small black one—is of the house-fly species, called *Anthomyia meteorica.* Such flies call to mind the plague of flies in Egypt, and enable us to understand what an intolerable nuisance they must have been : darkening the air with their numbers, filling every room, settling on food and drink, on face and hands, entering the eyes, ears, nostrils, and the mouth ; flies above, beneath, around; flies everywhere. Among the sculptures of ancient Egypt is the representation of a monarch, with his servant bearing a flapper of horse-hair to keep away the swarms. They are to this day a pest in the land. One species in particular attack the eyes of sufferers from ophthalmia. The Egyptians call it the Sand-fly; other nations the Black-fly. Its scientific name is *Simulium.* It is a near relation of the *Bibio*, common about our hedges. This black fly is often called by travellers the Mosquito. Though small, its oral structure is fully developed, and it is more venomous than the *Culex-mosquito.* It is very generally distributed, but fortunately rare in England. Wherever it abounds, it is the scourge of the country. North Lapland and parts of North America are particularly afflicted by it. In Senegal the wretched inhabitants light a fire, and sitting above it, envelope themselves in smoke to keep off the flies of the country; probably this black fly. Perhaps it was the same fly from which an exploration party suffered so severely in the deserts of Western Australia. If it were *these* flies which afflicted Egypt in the time of the Pharaohs, it was a terrible scourge indeed.

But the flies of the plague of Egypt might have been Mosquitos. Ancient history tells of a king of Persia being forced to abandon the siege of a town by swarms of mosquitos, which attacked his cattle and his army. Captain Burton, when travelling in North America, mentions the trouble his party had with these insects during his progress by the Red River; while such places as Mosquito Bay, St. Christopher's; Mosquito Town in Cuba; and Mosquito Country, North America, sufficiently indicate by their names the uncomfortable position of their inhabitants.

The common Gnat of our own country is a very near relative of the Mosquito, and sufficiently venomous to be guarded against. The Midges, also relatives of the foregoing, are minute and pretty to look at, but very blood-thirsty. The flesh-fly, *Sarcophaga*, has the singular property of hatching its eggs in its own body, and bringing forth its young alive. Whilst dissecting some specimens, and before I had entered upon the literature of the subject, I discovered this. In one instance, a larva was found in the act of passing the oviduct. This specimen I have mounted.

The fact is well known. It has a good illustration in the case of the green fly, one of the so-called plant-lice of the garden. A still better illustration, because more easily seen, is afforded by the little *Daphnia*, or water-flea. Neither of these is related to our fly, though they agree in being viviporous, or, more correctly, ovo-viviparous. But I was a witness to the fact as to the green fly, which came about in this way :—I was searching webs of the spider for the *Polynema*, and having found one, I brought away with it one of the green flies. Upon examination under the microscope, it proved to be alive, and struggling to get free from the web. About it were other little things, much smaller than itself, of a larval form, also alive and struggling. The sight was a curious one, and set me thinking. I was not long, however, in coming to the conclusion that I had before me a mother and her offspring, and that she, small and despicable, and hated of all gardeners, had the property of bringing forth her young alive.

Forest-flies—or, as French authors term them, Spider-flies—carry reproduction to a still higher development. They are parasitic on the bodies of quadrupeds. In this case, not only is the larva hatched in the body of the female, but its change to a pupa state takes place there also. Not until then is the egg-like form deposited, and from this issues the perfect insect. But remarkable as these instances are as to the reproductive faculty of some insects, they are altogether eclipsed in the history of another, also belonging to the Diptera, or Fly order.

Eighteen years ago there appeared an article in a foreign Journal, stating that a certain fly had been found with larvæ, which were not only alive, but had living larvæ inside them. The article had been kept back two years by the publishers, because the statement "seemed almost incredible." When at last it did appear, it was received with general incredulity, and declared to be "a pure and simple delusion."

Other men, however, investigated the matter, and ample testimony established the fact beyond dispute. The author of the paper was Professor Wagner, of Kasan. The remarkable fly was the *Micastor metraloas*. It is small in size, gnat-like in appearance, with beautifully iridescent wings, long antennæ, and very long legs. The paper went on to state that the larvæ, while in the body of the female fly, produced other larvæ, which in their turn produced others, and so through successive generations during the winter and spring. In the summer, the last of the brood went through the usual changes, resulting in mature males and females. These latter, in their turn, laid eggs, and so the cycle recommenced. A writer well observes :—" Of all the marvels in the history of insects this is the most astonishing."

Mr. Pascoe appears to have been the first to bring it before an English audience in his address as President of the Entomological Society. This was in 1866. In the following year, Sir John Lubbock, the then President, again introduced it, fully confirming the extraordinary fact, and adding details as to the origin and mode of reproduction. I may add that I fancy I have one of these flies in my collection, and if so it is additionally interesting from having a string of eggs attached to its body. It was obtained, like many other interesting objects, from the web of a spider.

While all flies agree in having two wings, except some that are parasitic, and have none at all, the utmost diversity prevails among them as to size, form, colour, habit, and disposition. Some are large, measuring an inch in length, and stout in proportion, such as the Cleg or Gad-fly ; while others are so small,—and these are among the most beautiful,—as to be scarcely discernible. Some are very robust, like the Unicorn-flies, and others are so attenuated as to look like tiny twigs. Some are hairy as well as large, and are often mistaken for bees, which they much resemble, while others are more or less destitute of hairs. The Unicorn-fly, again, is distinguishable for its needle-like proboscis, standing straight and stiff from its head. Others have a proboscis likened to the beak of a bird, while others show little or none at all. There is much diversity of colour in flies. Many are dull-coloured, but many also are resplendent with blue or green or gold; others have golden stripes and bands on a dark ground; others, again, are silvery; while some have a general hue of brown and green and yellow of a more sober kind.

The habits of flies are as various as their colours. Some keep to the house or the stable, some live abroad, while others prefer a change; some delight in sunshine, and sip nectar from the flowers, while others delight in evil odours, putrescent meats, and decayed vegetables. Others, again, are predaceous, and live upon their fellows. They differ also in disposition. Some are innocent, others are crafty, blood-thirsty, and cruel. Some among them are dreaded by man and beast, such as the Black-fly, the Mosquito, the Gad-fly, and the Tsetse.

A plea has been put in on behalf of the fly for its use in the fertilisation of flowers. It is said that Bees only frequent those that are sweet-smelling and bright in colour; whereas flies prefer those which are characterised by very evil odours, and those that are reddish or yellowish-brown. Another plea is their use as scavengers. In this connection a computation has been made that the produce of one fly in the season can devour the carcase of a horse in the same time that a lion would do.

Let us hear what one of our poets says; perhaps he is addressing insects in general, but his address to them will include our subject:—

"All the fields which thou dost see,
All the plants belong to thee!
All that summer hours produce,
Fertile made with early juice;
Man for thee doth sow and plough,
Farmer he and landlord thou."

A word as to the enemies of the fly. They are many. Man poisons them; birds devour them; their fellows, wasps and spiders, live upon their juices; while some of them are subject to a singular disease of a fungoid character, which has received the euphonious name of *Empusina*, which soon kills them.

Still, numbers must survive, for they are occasionally seen in mid-winter, when the weather is mild, and in early spring when the sun is bright and warm; and the question has been asked, where do they go and hide themselves? As far as I am aware, no better answer can be given now than was given 150 years ago:—

> "From every chink
> And secret corner, where they slept away
> The wintry storms—or rising from their tomb
> To higher life—by myriads forth at once
> Swarming they pour."

Let us now enter upon the life-history of a Fly; and, passing from the general to the particular, take the House-fly for our type, combining with it for purposes of illustration the almost equally common and well-known Blow-fly. There are differences as to habit as well as to size; but as far as I am aware there is not much difference anatomically, except that of a larger development.

Is there any analogy between this Fly and the Worm? The question seems startling at first sight. But when we are told that the great French naturalist—Cuvier—was of that opinion, and actually classed them together, and that the late Professor Busk supported it, we must needs conclude that there are weighty arguments in favour of it. It has been well observed that "The lowest creatures in any particular section strongly resemble, when in their perfect form, the early or embryonic stage of the higher animals in the same section; the latter undergoing changes of form and structure before assuming their perfect state." This statement is well illustrated in the case of our Fly.

There are four stages in its life-history: the egg, the larva, the pupa, and the imago. Leaving the first stage—the egg—simply remarking that it is soon hatched in warm weather, we come to the second stage, the larva or maggot. Shortly described, this is soft, destitute of legs, but having minute hooks for locomotion, cylindrical in form, and divided into rings. In the worm, also, the body is soft, destitute of legs, having hooks for locomotion, is cylindrical in form, and divided by rings—"articulated," as naturalists say. It is said also that internally their physiology is the same. Thus explained, the analogy would seem to be established: that is to say, between the worm in its perfect state and the fly in its larval or imperfect state. It does not remain long in this condition, though while it does it eats voraciously as if the whole object of its life was only to eat, as indeed is probably the case, whilst it fulfils the office of scavenger. It now changes into the third or pupa state; in which condition it eats nothing, is motionless, and apparently without life. But a wonderful transformation is going on inside the hard fusiform case. A body highly organised is being formed; and presently when the case opens there appears, instead of a repulsive maggot, a fly symmetrically formed, having wings and all appliances exquisitely adapted for its new life—

> "Startling the eye
> With unexpected beauty."

Say, shall we welcome it? Shall we say with one enthusiast—

> "Busy, curious, thirsty fly,
> Drink with me, and drink as I"?

Curious truly, thirsty as we all know, and busy as some of us know only too well, when we take an afternoon's nap in the summer. It may be added that it is also of a somewhat frolicsome humour.

There is an anecdote told which well illustrates these traits of our little friend, and may be given here, though probably known to some of our readers. An artist relates that while giving a lesson on miniature painting he was called out of the room just as he had finished the eye. Greatly to his surprise, on his return, the eye was gone. He looked at the pupil's little brother, who had been left alone in the room, but forbearing to find fault, he painted in the eye again. He had scarcely finished it, when he was again called away. Upon his return a second time, the eye was nearly gone. He did not hesitate now to accuse the boy of the deed, who indignantly denied it. But the eye was gone; and the question, "Who took it away?" still remained unanswered. Presently, turning to the miniature, the real culprit was found to be a fly, who, curious and thirsty, had returned to finish his repast, and was sucking what remained of the eye.

A glance at a Fly shows it to be divided into three parts, viz., the head, thorax, and abdomen, and to have six legs and two wings. This is all very evident. But what is not so easy—indeed not at all easy—is to make out the segments of the body. These are said to be thirteen in number, of which the head is one. Our difficulty begins with the thorax, which consists of three divisions or segments. Each of these has a name: the first is called the pro-thorax, and bears the first pair of legs; the second, the meso-thorax, which is much the largest of the three, bears the second pair of legs and the two wings; and the third, the meta-thorax, bears the third pair of legs. This segment has also a pair of curious organs called halteres or balancers. They are very much shorter than the wings, and end in a knob. Their use is not known. As they occupy the place of the hind wings in four-winged insects, some suppose they are rudiments of these wings. It is known that in flying they are in quick vibration, and some therefore have concluded that they help to steady the fly, and have called them balancers. This is one of several problems which the little House-fly offers for solution.

The abdomen has nine segments. Six of these are easily distinguishable; not so the other three. We have thus made out the thirteen segments. But it should be mentioned that some authors call the number seventeen. They say the head is composed of five segments instead of one, so the difference lies in the head only. Of the skin, or integument of the fly, it will suffice to say that it is at once a marvel of lightness, thinness, strength, and elasticity.

Turning again to the head, there will be seen, standing out in front, two small organs called antennæ, having several joints; the most conspicuous of which is like a short club with a feather fixed to one of its sides. The use of these organs has hitherto baffled investigation. The general opinion seems to be that they are feelers, and have a sense with which we are unacquainted.

The eyes are immovable and compound, having lenses or facets hexagonal in form, numbering altogether about four thousand. Though so numerous, they each have a tube leading to the brain, called a pyramid or cone, because of its length and form. Wonderful to relate, these are all isolated from each other by red-coloured pigment. It is by these cones that the impression of objects in the field of view is conveyed to the brain. An opinion prevails that no two lenses see the same object at the same time; but when it is remembered that we ourselves see an object with both eyes without confusion, it is not difficult to conceive that there may be no confusion in the sight of the fly, though the image is seen by several lenses at once. Besides these large compound eyes, there are on the crown of the head three small and simple ones, called ocelli.

The proboscis of the house-fly is bi-lobed at the extremity, and adapted for sucking only. There are no lancets, as such, but between the two lobes there are three rows of so-called teeth, which may be used on occasion to triturate sugar and such-like food. The proboscis of the Blow-fly only differs from that of the House-fly in being larger. Its interest and beauty have made it the most popular object for the microscope. While looking at it there will be seen two club-shaped appendages with short bristles about them. They are supposed to be organs of taste, and are called palpi. Whilst flies have only two, other insects have four of these organs.

The connection between the head and the thorax is by a pedicel of small diameter. The wasp, one of the enemies of the fly, would seem to know this; for in his attacks, his first effort is to bite through this, which he does easily. Twice has the writer seen this done, and the fly rendered helpless by the loss of its head.

Turning to the thorax, the first organs to attract our notice are the wings, which are membranous, having lines running along them, called nervures. These, and the spaces between them, are severally named; being found useful in separating flies into families. The wings are set in motion by very powerful muscles, and make an extraordinary number of vibrations in a short space of time; one authority says, six hundred in a second, and that one-third of a mile can be traversed in a minute. Another authority tells us that the wings make a little over twenty-one thousand vibrations in a minute. These produce the musical note "*F*," which is known to require this number of vibrations, and thus the number is ascertained.

The legs are five-jointed: the last joint of these, called the tarsus, or foot, being also five-jointed. At the extreme end are two claws, likened to rams' horns, and two pads covered underneath with short hairs, which are hollow. It is these hairy pads which enable the fly to perform the wonderful feat of walking upon glass, and along ceilings body downwards. It was formerly said that the hairs of the pads being hollow acted like suckers. The general opinion now is that they emit an adhesive fluid. This would seem to be the case, for on putting a fly into a live-box, feet upwards, and looking through the microscope it is found that as the fly moves its feet on the glass, a fluid is left behind. Many, however, believe that both the vacuum and the fluid are employed.

Leaving these larger members, let us examine the thorax a little more closely. We now see that there are two tiny reddish spots on what we may term the shoulders, one on each. These are breathing pores, by which air is admitted into that part of the body. Very curious they are; and answer their purpose admirably. It is necessary to admit air, and quite as necessary to exclude dust, or the poor little thing would soon be choked. Both purposes are secured by making an opening, and covering it with hairs, interlacing each other with such closeness that no dust can penetrate. Besides these two comparatively large pores—or spiracles, as they are called—there are many other smaller ones distributed about the body, so that air is admitted into every part.

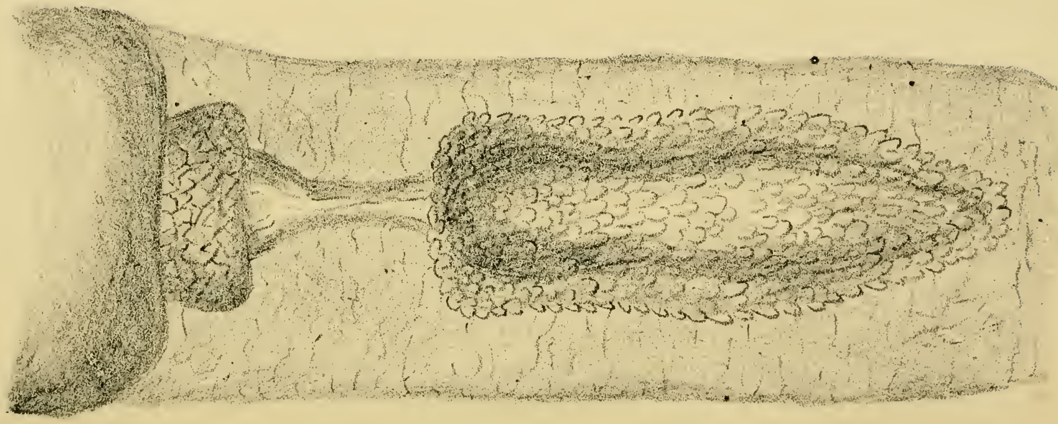
Admirable as is the external structure of our little fly, its internal structure would appear to be even more so; for while it has all the senses we have, it is supposed to have one or more that we have not. It has also such organs as those of respiration, circulation, feeling, nutrition, reproduction, accompanied with muscles, glands, and other processes; and all these so connected one with another, as to be mutually supporting and adaptive to each other's requirements.

The air vessels sometimes take the form of globes—or sacs—such as the two in the abdomen, which are very conspicuous, and others in the head, which together must give great buoyancy to the fly. Those around the thorax and abdomen are tubes, relatively large, which are connected with the outer air by the breathing-pores or spiracles, before mentioned. From these smaller tubes radiate into all parts of the body and among its various organs, and away to the ends of the legs and antennæ, getting so fine in some instances as to require a high power to reveal them. The tubes are called tracheæ. They are like spiral coils of wire with an inner and outer coating, and are hollow throughout, even to the most minute ramification. Being in this form, they are elastic, and adapt themselves to every movement of the body without collapsing, and without preventing the circulation of air.

The fly has an organ which answers the purpose of a heart, though it is not heart-shaped. It is called the dorsal vessel, because it runs along just inside the back. It runs thread-like through the thorax, and enlarges considerably as it enters and passes along the back, and is here divided into spaces by valves, which open and shut as required. As there are beatings in our own heart, so there are pulsations in the heart of the fly, caused by contractions of the organ in both cases. These pulsations have been witnessed as well as the circulation in the wings of young flies. This heart—or dorsal vessel—enters the head, where it ramifies, and passes to the further extremity of the abdomen. There do not appear to be arteries and veins, although the blood is known to circulate into all parts of the body and its members; it then returns to the heart through its valvular openings to be again dispersed. It has been suggested, and I think it probable, that the ductless glands which line the inside of the abdomen, and are intimately connected with the heart, collect the blood and direct it to that organ.

The fly has also a nervous system, and therefore it has feeling. There is a chord, running like the heart, throughout the whole length of the body, but, unlike the heart, it is placed just inside the underneath part of the abdomen, and hence is called the ventral chord. It commences in the head, where it has ramifications to the antennæ and eyes, and all other parts. Entering the thorax, it forms a large ganglion, which gives out branches to the legs and wings, and equally large ones to the halteres or balancers. Then passing through the abdomen, it sometimes has one small ganglion about the centre, and always a larger one at the end, where it ramifies again in all directions, becoming at length so exceedingly fine as to be lost to view.

The nutritive system of the House-fly is also highly organised. I am accustomed to say to my friends that the fly is a ruminating animal, though I have not met with the term in any authority,



and it may not be, therefore, strictly correct. But if I can fairly describe what I have seen, my readers, I think, will be of opinion that there is good ground for the suggestion. At the end of the tongue is a tube which passes into the thorax, where it is at once connected with a button-like process at the commencement of the chyle-stomach. This tube then runs along away through the thorax into the abdomen, where it swells out into a pouch of two lobes. Here the food is in the first instance received, and stored up as it is similarly stored in the paunch of the ox, sheep, and goat. When full it is distended to an enormous size. From this, at its leisure, our little fly sucks up its nutriment; perhaps into its mouth. Whether so or not, the food certainly passes into the button-like process—called a proventriculus—which is divided into compartments, and so through the chyle-stomach into the intestine. This is convoluted in the abdomen, and when drawn out is about three times the length of the fly itself. Towards the end is a singular and beautiful process, called by Mr. Lowne, in his work on the Blow-fly, the "Rectal Valve"; but I think it is not correctly figured there. I have dissected it out, and found it to be reticulated, or net-like (see Plate XXVI.); then after contracting very much it enters a cup-like part, which is again contracted so as to take the form of a funnel. After this the intestine swells into a large sac, or bag, having four curious processes, called by Mr. Lowne "Rectal Papillæ." From being supplied with comparatively large air vessels, they are evidently important in the economy of the fly, but for what purpose is not clearly known.

The next thing to notice in connection with the alimentary canal, or nutritive organs, are the salivary glands. These, like the other organs described, commence in the head. In the thorax they take, in the House-fly, and also in the Blow-fly, a convoluted form on either side of the chyle-stomach. On entering the abdomen they are straight, and the two pass on to the end.

There is still another adjunct to mention, namely, the long bead-like processes attached to the lower part of the alimentary canal, and supposed to be biliary ducts. It will thus be seen that this organ is most highly developed.

The reproductive organs again are a study of themselves; but it will make this paper too long to attempt their description.

The ductless glands, before alluded to as lining the coats of the abdomen, and serving as aids for the circulation of the blood, must also be left for the present.

Not so, however, the muscles. Distributed throughout all parts of the body for individual movement of each member, they are mustered in strong force in the thorax. Indeed, they almost fill this region, so many and so large are they. Their function is of course to give energy to the wings especially, and also to the legs and halteres. Part lie at the sides of the thorax, running from back to front, so to speak, and part lie between these, and run along from the head to the abdomen. They consist of bundles, and these again are separable into filaments. They are plentifully supplied with air, having air-vessels running among them in all directions.

Thus my paper, but not my subject, comes to an end. Though very imperfect, it will at least serve to show that the despised House-fly is not so insignificant as it appears, even in itself; while as a member of a community so widely spread and so numerous, and so potent for good and ill, it takes a very important position indeed.

"Think naught a trifle, though it small appears;
Small sands a mountain, moments make the year,
And trifles life."

Imitative Colouring in Fish.

By John Brigg.

THE fish upon which I have tried my experiments are common Goldfish. A few words as to the condition in which they usually live and breed may not be out of place. The large supplies which find their way to the London market are derived principally from the mill-dams in Lancashire and Yorkshire, where steam-power is used. Two conditions are necessary in order to rear Goldfish in large quantities, viz., clean water and a warm temperature. It will thus be seen incidentally that the supply is limited, inasmuch as the proper conditions are not always attainable. For condensing purposes a bountiful supply of water would not be stored at all after once being used, but allowed to run waste. On the other hand, a scant supply would often become hot and dirty by frequent usage, and so become unfit to sustain healthy life. Goldfish are carp, and are found in the same pond in considerable variety of colour, from sooty black to white, with all shades of gold and yellow intervening. They are often coloured in patches of red and black or red and white; very rarely all three colours are found, but never, so far as I know, are black and white found in the same fish without some admixture of red. The circumstances which gave rise to the present investigation are as follows: Some two or three years ago, a mill-dam in which large numbers of Goldfish were being reared became tenanted by a water weed *(Potamogeton)* which had been accidentally introduced by the nets of the man who rented the fishing. A short time sufficed to develop the growth of the weed to such an extent that a net could not be used for fishing without first cutting away the weeds by means of ropes or wire; and further, it was found that in some twelve or eighteen months' time the proportion of Golden-coloured fish to that of the dark and black ones was considerably diminishing, and in two years the number was so reduced that it was scarcely worth while to fish the pond at all. To remedy this state of things, and find means to ensure a more certain supply of Gold and Silver-coloured fish, is the object now in view. I trust we shall be able to show how a considerable change may be made in the shade of colour both in red and black specimens, but the knowledge how to change the colour entirely is still a mystery which is unsolved.

Leaving the ultimate result, which may possibly require years to work out, I will direct attention to the different shades of colour which are caused by the number and disposition of the dark pigment cells contained in the outer skin of fishes. The real colour of the skin or scale may be yellow or transparent, but the distribution of the pigment cells allows only part of the underlying colour to appear. Thus we have different shades of colour, varying from grey-silver, or pale yellow, to deep red, or velvet-black. With this knowledge a considerable number of experiments have been carried on, in order to remove the dark cells entirely, and thus leave the true colour always visible. Our success in this direction has been very small. The principal result has been to make us familiar with the different forms assumed by the pigment cells, and the means by which the changes can be most easily brought about. Our observations having been made upon fish having scales, has been rather a disadvantage, obliging us to depend more upon the fins and tail than the general changes in the body. The skin underneath those scales having black pigment cells on their surface, is usually found deeply dyed by pigment; the eye and the interior walls of the abdomen are also deeply set with dark cells. It is difficult to say how far the violence done to a fish by taking it out of water, or removing a scale, or cutting off part of a fin, may disturb the nervous action through the whole body, but judging from a large number of examinations made under different conditions, it appears that the cells under ordinary circumstances are to be found displaying at one time almost all the forms of which they are capable; some having the form of a sphere, some flattened and showing broken margins, some having tongue-like projections two or three in number; while others extend in radiating arms until the central nucleus almost entirely disappears; and in some the extension of the cell has been carried so far that the colour is pale grey, hardly distinguishable from the skin substance in which it is embedded. To alter the form of these cells and cause them all to take on a similar action, it is only necessary to expose the fish to different kinds of reflected light. The light from a white porcelain dish causes the contraction of all the cells into the least possible space, and when continued, causes the cells to become small black globes; conversely, when a fish is placed in a black dish, the cells commence to extend in every direction until they frequently touch and interlace with each other.

Ordinary cold water and the simplest means have been found as efficient as the most elaborate precautions. We have tried globes coloured inside with red, blue, yellow, and green; we have also used different colours of glass, so that the *light* within the globes should be tinted according to the colour employed, and used the greatest care so as to carry on our experiments in warm water and under conditions as nearly as possible similar to those in which the fish had been living. Our experiments seem to prove that coloured light has no effect except in so far as it approximates to black or white. Bright light alone is not sufficient to affect the pigment cells to any appreciable extent. A fish placed in a globe of clear glass and exposed to the fullest sunlight retains its normal colour. Nor does absolute darkness effect any marked change. A series of trials carried on with great care have shown that a fish whose shade of colour has been artificially heightened will, on being taken into the dark, and there placed in a vessel of the contrary colour to that in which it had recently been, lose the abnormal colouring and resume the original shade, but will not be affected further by the colour of the vessel to which it has been changed. There can be no doubt that the eye is the medium by which the effects of reflected light is conveyed to the brain. Fish naturally blind, as well as those which have been made blind, are always normal in shade, and cannot be influenced by changes of the ground colours. It would thus appear that all changes to lighter or darker, are due to a certain amount of excitement caused by the reflected light of the ground over which they are floating. M. Georges Pouchet, who has made some observations on Sea-Fish at the Aquarium of Concarneau, has come to the same conclusion; and, in endeavouring to follow out the means by which the power of change was transmitted to the surface of the skin after the nerves leave the brain, believes he is warranted in saying that it is the nerve *bundles*, not the nerves which accompany the vessels, which are the real regulators of the function. Our fish have been so small that we have been unable to follow the experiments described in M. Pouchet's paper.

The colouring matter which gives the gold tinge to most of the black fish, and which appears unshaded by black in the ordinary Gold fish, is not so well defined into separate cells as is the black matter; it is, however, subject to the same changes when exposed to different kinds of light; and fish, which are only yellow when in a white vessel, become dark gold when placed in a black vessel. In one instance, by exposing a silver fish having occasional red scales on different parts of its body, to a bright white reflected light, we have succeeded in causing some of the red spots to disappear entirely. The converse experiment, to ascertain if, by exposure on a dark ground, the red spots would not re-appear, was neglected. In talking over this question with Mr. Long, the obliging manager of the Southport Aquarium, he mentioned several facts respecting Hippocampi and Turbots worth noting, which it is satisfactory to find quite confirm some information given to M. Pouchet by the manager of the Aquarium at Concarneau. He also stated that he had found the Eledone exceedingly sensitive in the matter of colour changes; a blow with the hand against the glass of the tank in which the Eledone was confined, was sufficient to change its colour immediately from pink to dark crimson. Young Squids he had also found to be very sensitive, but the causes for the changes he could not trace; they appeared to change without any exciting cause whatever. Incidentally he stated that the whole life of the Octopus did not exeed five or six months. If that is true in the case of a creature so highly organised, there appears good ground for expecting great activity in its organic functions; and imitative colouring, for the purposes of protective mimicry, would be of great value in the defence of its short but active life.

Respecting the Hippocampus, M. Pouchet mentions that the male, after the breeding time, has been noticed to turn pale. Mr. Long states that some time back, in order to brighten the appearance of the tank in which the Hippocampus was placed, he obtained blocks of white veined stone and placed them in the water; he was much startled next morning to find that most of the creatures had lost their brown mottled appearance, and those which had anchored themselves in front of the white blocks were so pale that he at once concluded they were dead; on removing the blocks of stone they all resumed their former colour. Mr. Long's description of the changes in Turbot far exceeds anything which was seen by M. Pouchet at Concarneau, and if supported by further experiments, which he has kindly promised to carry out on my account, brings us face to face with facts which will prove most interesting to anyone who can investigate and satisfactorily account for them.

The Turbots placed in the tanks of the Southport Aquarium were at first all dull brown or inclining to a slaty hue, according as they had been caught on a sandy or muddy bottom. Mr. Long, for the purposes of giving the bottom of his tanks a cleanly appearance, and also to prevent the Turbots from burrowing in any mud which might accumulate, supplied the tanks with a partial covering of shingle, which he obtained from the shore near Brighton; this shingle is screened, to pieces from one inch to half an inch in diameter, and is made up of bright brown pebbles interspersed with white ones of similar dimensions. He found that all the Turbots had taken up the colouring of the pebbles, and became coloured brown with white spots, agreeing exactly in shade with the pebbles on which they lie. It is difficult in this case to accept the theory which has appeared possible in the case of other fishes, as it is almost certain that the Turbots could never either for themselves or through hereditary transmission have had experience of living on pebbles assorted to a certain size and of two colours; and it is, moreover, believed that they are never found on shingly shores at all, but only where they can easily hide in sand or mud. It is difficult to imagine that the position in which the eyes are placed is favourable for the constant observation of the ground over which the fish is passing. A group of nerves also, which, however they might become habituated to the simple changes required in contracting or dilating a set of pigment cells, would require considerable tuition before they would learn automatically to accommodate their changes to the size of the pebbles which happened to be present at the bottom of the tank. Our experiments with frogs seem to point in the same direction as those with fishes; a few minutes' exposure in a white vessel is sufficient to contract the dark pigment cells and disclose the underlying yellow and green skin-colour. The same action is traceable in many other animals, especially in those which live in water. Professor Miall suggests that as cones in the retina indicate perception of colour, the eyes of fishes and frogs should be carefully examined. It is found that the cones are comparatively scarce in mammalia, but plentiful in birds; he says, "there is reason to suppose that the cones are specially connected with the colour-sense. These are abundant in and about the yellow spot in man and other primates, but usually few in other mammalia." Thin slices are easily cut from a retina which has been hardened with *potassium bichromate*, and subsequently in alcohol. Teased out osmic acid preparations are also good.

We have spoken of imitation of colour only, but the same principle holds good in many cases with reference to form, habits, sound of voices, smell, taste, and in insects probably other senses quite unknown to us. We thus get a glimpse of the Infinite, and see how very little we yet know of the commonest phenomena of nature.

Methods of Microscopical Research in the Zoological Station in Naples.

By C. O. Whitman.

From "The American Naturalist."

FIRST PAPER.

IN the preparation of this paper, Dr. Mayer has allowed me to make free use of his excellent article,* published about two years ago. I have added the methods of Dr. Giesbrecht, Dr. Andres, and some others who have worked in the zoological station. Dr. Mayer has further placed at my disposal such improvements and alterations as he has been able to make since the publication of his paper. I am also deeply indebted to Dr. Mayer for advice and generous assistance, for which I wish here to give expression to my most sincere thanks and grateful appreciation.

I am still further indebted to Dr. Eisig, Dr. Lang, Dr. Andres, Dr. Giesbrecht, Professor Weismann, and Professor Dohrn, all of whom I have had occasion to consult with reference to matter contained in this paper.

I.—Preservative Fluids.

Killing, Hardening, and **Preserving,** are three kinds of work, requiring for their accomplishment sometimes only a single preservative fluid, but in most cases two, three, or even more. As

* Mayer. "Mittheilungen aus der Zoologischen Station zu Neapel." Vol. II., p. 1, 1880.

the same fluid often does the work of killing and hardening, and sometimes of preserving too, it is impossible to divide them into three classes corresponding to the kinds of work, except by repeating many of them twice, and some of them three times. While it is therefore more convenient to include them all under "preservative fluids," as Dr. Mayer has done, it is none the less important to remember what kind or kinds of work each fluid is expected to accomplish.

Kleinenberg's picro-sulphuric acid, for instance, now so much used in the Naples Aquarium, is not a hardening fluid. It serves for killing, and thus prepares for subsequent hardening.

1. **Kleinenberg's Fluid.***

Picric acid (saturated solution in distilled water)	100 volumes.
Sulphuric acid (concentrated)	2 "

Filter the mixture and dilute it with *three* times its bulk of water;† finally add as much creosote ‡ as will mix.

Dr. Mayer prepares the fluid as follows :—

Water (distilled)	100 volumes.
Sulphuric acid	2 "
Picric acid (as much as will dissolve).	

Filter and dilute as above. No creosote is used.

Objects are left in the fluid three, four, or more hours; and are then, in order to harden and remove the acid, transferred to 70 per cent. alcohol, where they may remain 5—6 hours. They are next placed in 90 per cent. alcohol, which must be changed at intervals until the yellow tint has wholly disappeared.

Summary of Dr. Mayer's remarks on Kleinenberg's Fluid.—The advantage of this fluid is, that it kills quickly, by taking the place of the water of the tissues; that it frees the object from sea-water and the salts contained in it, and that having done its work *it may be wholly replaced by alcohol.* In this latter fact lies the superiority of the fluid over *osmic* and *chromic* solutions, all of which produce inorganic precipitates, and thus leave the tissues in a condition unfavourable to staining. Picro-sulphuric acid does

* *Quart. Journ. Micro. Sci.*, Vol. XIX., pp. 208—9, 1879.

† Dr. Mayer uses the fluid undiluted for Arthropoda.

‡ Creosote made from beechwood tar.

not, like chromic solutions, harden the object, but simply kills the cells.

As this fluid penetrates thick *chitine* with difficulty, it is necessary, in order to obtain good preparations of larger Isopoda, insects, etc., to cut open the body and fill the body-cavity with the liquid by means of a pipette. In larger objects care should be taken to loosen the internal organs so that the fluid may find easy access to all parts.

The fluid should be applied as soon as the body is opened, so that the blood may not have time to coagulate and thus bind the organs together. *A large quantity of the fluid should be used, and it must be changed as often as it becomes turbid.* The same rule holds good in the use of all preservative fluids. It is well also, especially with larger objects, to give the fluid an occasional stirring up.

In order to avoid shrinkage in removing small and tender objects from the acid to the alcohol, it is advisable to take them up by means of a pipette or spatula, so that a few drops of the acid may be transferred along with them. The objects, sinking quickly to the bottom, remain thus for a short time in the medium with which they are saturated, and are not brought so suddenly into contact with the alcohol. In a few minutes the diffusion is finished; and they may then be placed in a fresh quantity of alcohol, which must be shaken up frequently and renewed from time to time until the acid has been entirely removed.

The sulphuric acid contained in this fluid causes *connective tissue* to swell, and this fact should be borne in mind in its use with vertebrates. To avoid this difficulty, Kleinenberg has recommended the addition of a few drops of creosote, made from beechwood tar, to the acid. According to Dr. Mayer's experience, however, the addition of creosote makes no perceptible difference in the action of the fluid.

This fluid must not be used with objects (*e.g.*, Echinoderms) possessing calcareous parts which it is desired to preserve, for it dissolves carbonate of lime and throws it down as crystals of gypsum in the tissues. For such objects—

Picro-nitric acid may be used. It is prepared as follows: —

Water	95 parts.
Nitric acid (25 per cent. N_2O_5) ...	5 "
Picric acid (as much as will dissolve).*	

Picro-nitric acid also dissolves carbonate of lime, but it holds it in solution, and thus the formation of crystals of gypsum is avoided. In the presence of much carbonate of lime, the rapid production of carbonic acid is liable to result in mechanical injury of the tissues; hence, in many cases, chromic acid is preferable to picro-nitric acid.

Picro-nitric acid is, in most respects, an excellent preservative medium, and as a rule will be found to be a good alternative in those cases where picro-sulphuric acid fails to give satisfactory results. Dr. Mayer commends it very strongly, and states that with eggs containing a large amount of yelk material, like those of *Palinurus*, it gives better results than nitric, picric, or picro-sulphuric acid. It is not so readily removed from objects as picro-sulphuric acid, and for this reason the latter acid should be used wherever it gives equally good preparations.

2. **Alcohol.**—In the preparation of animals or parts of animals for museums or histological study, it is well known that the chief difficulties are met in the process of killing. Alcohol, as *commonly* used for this purpose by collectors, has little more than its convenience to recommend it. Dr. Mayer has called attention to the following disadvantages attending its use in the case of marine animals :—

(1) In thick-walled animals, particularly those provided with chitinous envelopes, alcohol causes a more or less strong maceration of the internal parts, which often ends in putrefaction.

(2) In the case of smaller Crustacea,—*e.g.*, Amphipods and Isopods,—it gives rise to precipitates in the body-fluids, and thus solders the organs together in such a manner as often to defy separation even by experienced hands.

(3) It fixes most of the salts of the water adhering to the

* This mixture is used undiluted.

surface of marine animals, and thus a crust is formed which prevents the penetration of the fluid to the interior.*

(4) This crust also prevents the action of staining fluids, except aqueous solutions, by which it would be dissolved.

Notwithstanding these drawbacks, alcohol is still regarded at the Naples Aquarium as an excellent fluid for *killing* many animals designed for preservation in museums or for histological work. In many cases the unsatisfactory results obtained are to be attributed not to the alcohol *per se*, but to the *method* of using it. Most of the foregoing objections do not, as Dr. Mayer has expressly stated, apply to fresh-water animals; and Dr. Eisig informs me that he has no better method of killing marine annelids than with alcohol. Judging from the preparations which were kindly shown to me, and which were all beautifully stained with *borax-carmine*, Dr. Eisig's mode of treatment must be pronounced very successful. The process is extremely simple. A few drops of alcohol are put into a vessel which contains the annelid in its native element, the sea-water; this is repeated at short intervals until death ensues. After the animal has been thus slowly killed, it may be passed through the different grades of alcohol in the ordinary way, or through other preservative fluids. Objects killed in this manner show no trace of the external crust of precipitates which arises where stronger grades of alcohol are first used. The action of the alcohol is thus moderated, and the animal, dying slowly, remains extended and in such a supple condition that it can easily be placed in any desired position. The violent shock given to animals when thrown alive into alcohol of 40 per cent. to 60 per cent., giving rise to wrinkles, folds, and distortions of every kind, is thus avoided, together with its bad effects.

3. **Acid Alcohol.**—In order to avoid the bad effects of alcohol, such as precipitates, maceration, etc., Dr. Mayer recommends *acid alcohol*—

* Dr. Mayer first noticed this in objects stained with Kleinenberg's hæmatoxylin, and afterwards in the use of cochineal, where a grey-green precipitate is sometimes produced, which renders the preparation worthless. Such results may be avoided by first soaking the objects a few hours in *acid alcohol* (1—10 parts hydrochloric acid to 100 parts 70 per cent. alcohol).

95 volumes 70 per cent. or 90 per cent. alcohol.
3 ,, hydrochloric acid,*

for larger objects, particularly if they are designed for preservation in museums. The fluid should be frequently shaken up, and the object only allowed to remain until thoroughly saturated, then transferred to pure 70 per cent. or 90 per cent. alcohol, which should be changed a few times in order to remove all traces of the acid. For small and tender objects, acid alcohol, although preferable to pure alcohol, gives less satisfactory results than picro-sulphuric acid.

4. **Boiling Alcohol.**—In some cases among the Arthropods, Dr. Mayer has found it difficult to kill *immediately* by any of the ordinary means, and for such cases recommends *boiling absolute alcohol*, which kills instantly. For Tracheata this is often the only means by which the dermal tissues can be well preserved, as cold alcohol penetrates too slowly.

5. **Osmic Acid.**—Dr. Mayer employs osmic acid as a staining-medium for the hairs, bristles, etc., of the dermal skeleton of Arthropods. The lustre of *Sapphirina* is preserved by this acid,† and according to Emery, the colour of the red and the yellow fatty pigments of fishes.

Van Beneden found osmic acid the best preservative fluid for the *Dicyemidæ*, and my experience leads to the same conclusion.‡

Although Dr. Mayer seldom uses this medium where histological details are required, he observes that in those classes of animals whose bodies are easily penetrated with watery fluids, osmic acid is seldom to be dispensed with.

Bleaching.—It often happens that objects treated with osmic acid continue to blacken, after removal from the acid, until they are entirely worthless, and such results are even more annoying than the difficulties in the way of staining. It has been said that

* Acid alcohol as above prepared loses its original qualities after standing some time, as ether compounds are gradually formed at the expense of the acid.

† See corrosive sublimate, p. 107.

‡ One of the best objects for testing methods is found in *Phronima sedentaria*. Here the cells and nuclei are so sharply defined that they can be seen in the living animal, and so the effect of a preservative fluid can be easily studied.

the blackening process can be arrested by certain staining media, but it is certain that picro-carmine will not always do this, as some of my preparations of *Dicyemidæ* show. It is therefore a very important step which Dr. Mayer has taken in finding a method of restoring such objects. The method* is as follows :—*The objects are placed in 70 per cent. or 90 per cent. alcohol, and crystals of potassic chlorate* ($KClO_3$) *shaken into the liquid until the bottom of the vessel is covered; then a few drops of concentrated hydrochloric acid* † *are added with a pipette, and as soon as chlorine (easily recognised by its greenish-yellow colour) begins to be liberated, the whole gently shaken. As soon as the bleaching is finished, the objects are removed to pure alcohol.* By this method, Dr. Mayer has been able in half a day to restore large *Pelagia*, *Carinaria*, *Rhizostoma*, etc. Smaller objects generally require a shorter time and less acid. The process can be greatly accelerated by heating on a water-bath.

Using *Sapphirina* as a test-object, Dr. Mayer found that the lustre which characterises the living animal entirely disappeared by the bleaching process. As this lustre, which has its seat in the epidermis, depends on the interference of light, it is evident that the cells had undergone *some* change, but a change so slight that the tissues could hardly be said to have been injured for histological purposes; besides, the removal of the osmic acid leaves the animal in a good condition for staining.

Dr. Mayer's experience with *Sapphirina* appears to support him in the following conclusions in regard to the nature of the action of osmic acid,—viz., that the hardening effect of the acid is due to the formation of inorganic precipitates within the tissues. This is made evident by the fact that the animal becomes soft and flexible as soon as these precipitates are removed by bleaching.

This method of bleaching has been used by Dr. Mayer for removing natural pigment. Alcoholic preparations of the eye of *Mysis*, for instance, can be fully bleached *in toto*, but with better success by operating with single sections. To avoid swelling, which is apt to arise by the use of aqueous fluids, staining media of an alcoholic nature should be used.

* A slightly modified form of the method originally given in Müll. Arch., 1874, p. 321.

† Nitric acid may be used instead of HCl.

6. **Chromic Acid.**—Chromic solutions have, in common with osmic acid, the peculiarity of hardening by virtue of the chemical combinations which they form with cell-substances, and all the consequent disadvantages with respect to staining. The use of chromic acid in the Zoological Station of Naples may be said to have been largely superceded by *picro-sulphuric acid*, *corrosive sublimate*, and *Merkel's fluid*, for it is now seldom used except in combination with other fluids.* It is sometimes mixed with Kleinenberg's fluid, for example, when a higher degree of hardening is required than can be obtained by the use of the latter fluid alone. It is a common error to use too strong solutions of chromic acid, and to allow them to act too long. Good results are in some cases obtained when the objects are treated with a weak solution (⅓ to ½ per cent.) and removed soon after they are completely dead.

7. **Merkel's Fluid.**—

Platinum chloride dissolved in water	...	1:400.
Chromic acid ,, ,,	...	1:400.

Professor Merkel,‡ who employed a mixture of these two solutions in equal parts for the *retina*, states that he allowed from three to four days for the action of the fluid. Dr. Eisig has used this fluid with great success in preparing the delicate lateral organs of the *Capitellidæ* for sections, and recommends it strongly for other annelids. Dr. Eisig allows objects to remain 3—5 hours in the fluid, then transfers to 70 per cent. alcohol. With small leeches I have found one hour quite sufficient, and transfer to 50 per cent. alcohol.

8.—**Corrosive Sublimate.**—Prompted by a statement found in an old paper by Blanchard,‡ Dr. Lang began experimenting with corrosive sublimate as a medium for killing marine Planarians, and his marked success led him and others to employ the same

* Dr. Pfitzner ("Morph. Jahrb.," B. xvii., p. 731, 1882) has recently made use of chromic acid followed by (1) *osmic acid*, or by (2) *chloride of gold, formic acid*, and *safranin* (or hæmatoxylin) for the demonstration of nerve-terminations.

Flemming (see his method on a following page) believes that chromic acid is one of the most reliable fixing reagents for the karyakinetic figures, and has proved that objects hardened in this acid can be beautifully and durably stained.

† "Ueber die *Macula lutea* des Menschen," etc., Leipzig, 1870, p. 19.

‡ "Recherches sur l'Organisation des Vers," by Emile Blanchard. Ann. des Sci. Nat. Zool. Ser. 3, t. viii., 1847, p. 247.

with other animals. In most cases, Dr. Lang now uses a *saturated solution of corrosive sublimate in water.* A saturated solution in picro-sulphuric acid, which in some cases gives better results if a little acetic acid (5 per cent. or less) is added, is also used.* Blanchard's mode of treatment was to mix a quantity of the aqueous solution with the sea-water, and thus poison the animals. Dr. Lang, on the contrary, removes the sea-water so far as possible before applying the solution. With Planarians he proceeds in the following manner:—

The animal is laid on its back and the water removed with a pipette; the solution being then poured over it, it dies quickly and remains fully extended. After half-an-hour it is washed by placing it in water and changing the water several times during thirty minutes. It is next passed through 50 per cent., 70 per cent., 90 per cent., and 100 per cent. alcohol. In two days it is fully hardened, and should then be stained and embedded in paraffin as early as possible, as it is liable to become brittle if left long in alcohol. The time required by the corrosive sublimate varies with different objects, according to size and the character of the tissues. As a general rule, it may be said that objects should be removed from the fluid as soon as they have become thoroughly saturated with it. In order to kill more quickly than can sometimes be done at the ordinary temperature, the solution is heated, and in very difficult cases may be used boiling.

Corrosive sublimate has been used with success by Dr. Lang and others in the following cases:—Hydroids, corals, Nemertines, Gephyrea, Balanoglossus, Echinoderms, Sagitta, Annelids, Rhabdocœla, Dendrocœla, Cestodes, Trematodes, embryos and adult tissues of Vertebrates and, according to Mayer and Giesbrecht, Crustacea with thin chitinous envelopes—*e.g.*, Sapphirina, Copepods and larvæ of Decapods.

* These solutions given in *Zoolog. Anzeiger*, 1879, II, p. 46.

The original solution (*Zoolog. Anzeiger*, 1878, I, p. 14—15), now little used, stood thus:—

Distilled water	100 parts.
Common salt	6—10 ,,
Acetic acid	5—8 ,,
Corrosive sublimate	3—12 ,,
Alum (in some cases)	½ ,,

The two great advantages of Dr. Lang's method are—(1) that animals so treated are easily stained; and (2) they are killed so quickly that they are left, in most cases, in a fully extended condition. Hot corrosive sublimate kills leeches so instantaneously that they often remain in the attitude assumed the moment before the fluid is poured over them. The colour, however, is not so well preserved as when killed with alcohol, or even with weak chromic acid.

It should be remembered that objects lying in a solution of corrosive sublimate must not be touched with iron or steel instruments; wood, glass, or platinum may be used.

9. **Dr. Andres' Methods of treating Actiniæ.**—Among the various methods employed by Dr. Andres in killing the *Actiniæ*, the three following, given in the order of their excellence, are said to have worked most satisfactorily.

A. Corrosive sublimate.—With small animals, a hot solution, used in the manner recommended by Dr. Lang, gives good results; with larger animals, where this mode of treatment fails, the fluid must be injected. The cannula of a glass syringe, filled with the hot fluid, is inserted into the mouth at the moment it opens, which act habitually follows on gently touching the lip. After injecting, the hot solution is poured into the glass containing the animal and a small quantity of sea-water.*

If the operation is cleverly performed, the animal remains fully expanded, as the mechanical pressure of the injected fluid prevents contraction.

After from five to fifteen minutes the animal is washed in distilled water and allowed to remain twelve hours in 50 per cent. alcohol,† then passed through the higher grades of alcohol. Borax-carmine and hæmatoxylin used for staining.

B. Glycerine and Alcohol.‡—

Glycerine	...	...	...	20 parts.
Alcohol (70 per cent.)		...	...	40 ,,
Sea-water	...	...	...	40 ,,

* *Andres.* "Intorno all'Edwardsia Claparedii," in the Proceedings of the "Reale Accademia dei Lincei," Vol. v., Ser. 3, Mar. 7, 1880, p. 9.

† A little camphor (1 ccm. to 100 ccm.) added to the alcohol will facilitate the removal of the sublimate.

‡ This method originated with Salvatore Lobianco.

This mixture, poured very slowly into the containing-glass, often gives very good results, both for anatomical and histological purposes.

C. Nicotine and Tobacco-Smoke.—*a.* A solution of nicotine (1 g.) in sea-water (1 l.), conducted into the vessel containing the animal fully expanded in a half litre of sea-water, by means of a thread sufficiently large to empty the flask holding the nicotine solution in the course of twelve hours.

b. The vessel containing the animal in an extended condition, covered by a bell jar in which tobacco-smoke is confined, until the animal becomes completely benumbed.

After being deprived of sensibility by either of these methods, the creature may be killed in corrosive sublimate, or in picro-sulphuric acid.

D.—Dr. Andres finds that in the use of chloroform, dropped slowly into the water, or administered in form of vapour, maceration usually sets in before the power of contracting is lost. Good preparations of the internal parts may be obtained by injecting a weak solution of osmic acid. The method of freezing has also been employed with some success. For this purpose three vessels are placed one within the other, the central one containing the actinia, the middle one ice and salt, and the outer one cotton.

The ice containing the congealed animal is dissolved in alcohol or an acid.

E. Maceration.—It is often important to see the cells of a tissue *in situ* before freeing them with needles. In such cases Dr. Andres proceeds as follows :—

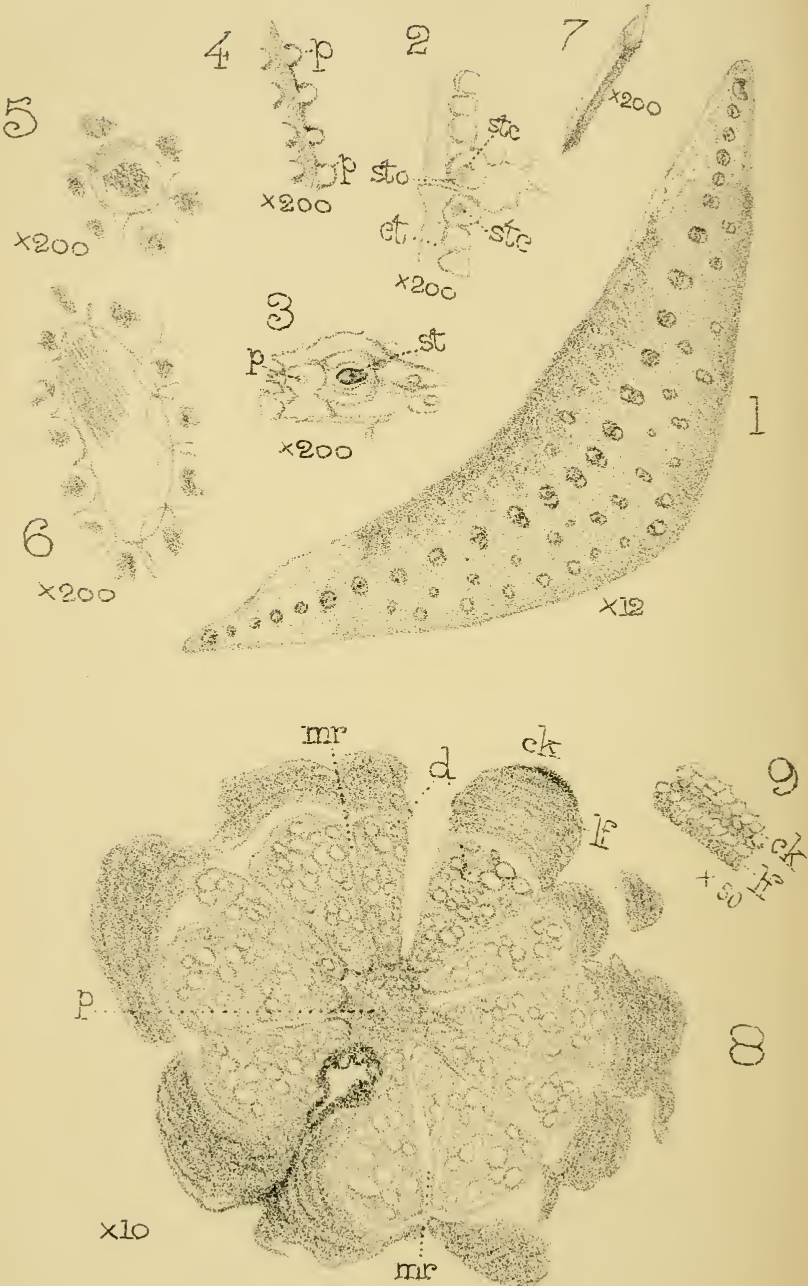
1.—Killed with corrosive sublimate.

2.—Left in 25 per cent. alcohol twenty-four hours.

3.—Soaked for a short time in a very thin solution of *gum arabic*, then in a somewhat thicker solution, and finally imbedded in a very thick solution.

4.—Hardened in 90 per cent. alcohol.

5.—Thick sections prepared for dissection with needles. The sections are placed on a slide in water, which dissolves the gum.


5
×200
4
p
p
×200
2
stc
sto
et
stc
×200
7
×200
1
×12
3
p
st
×200
6
×200
mr
d
ck
f
9
ck
f
×50
8
p
×10
mr

Half-an-Hour at the Microscope,
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

Plates 27—31.

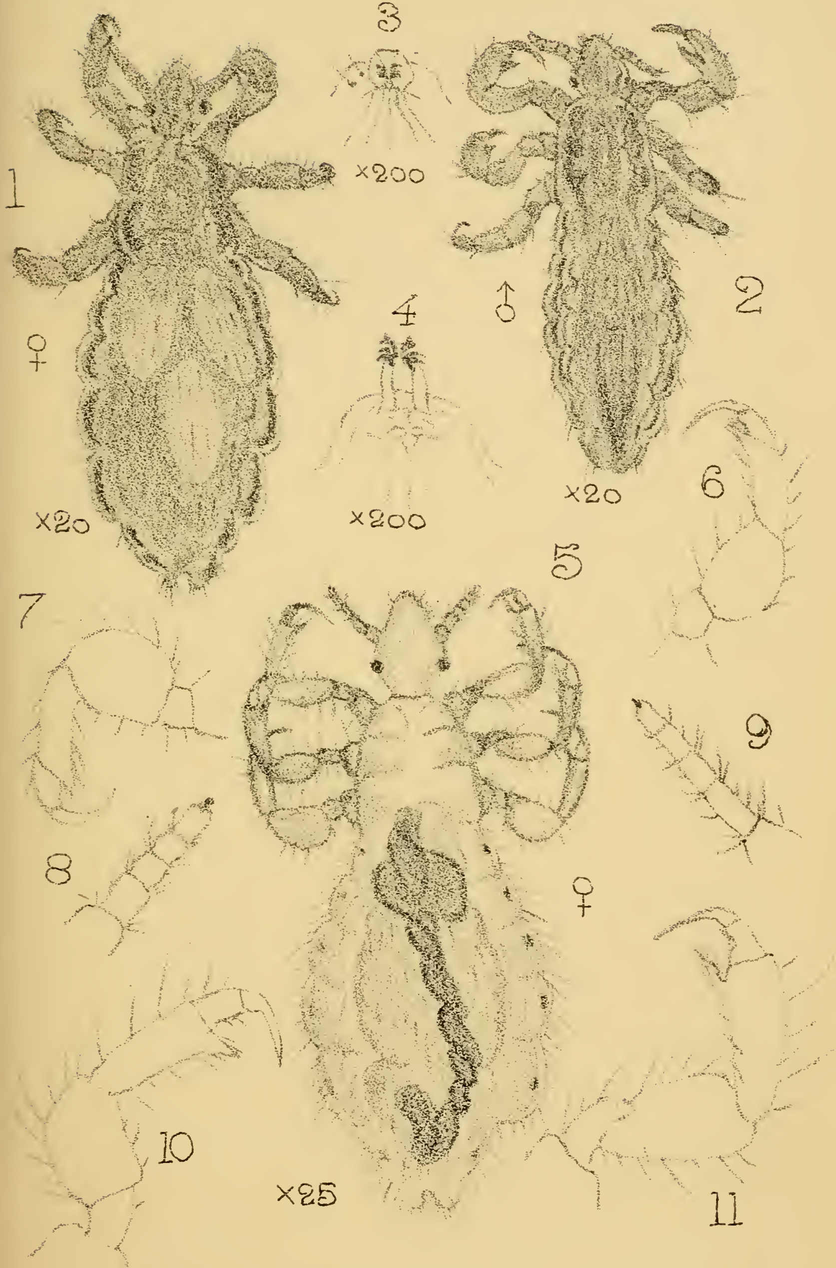
Yucca recurva (Pl. 27, Figs. 1—7).—Yucca belongs to the *Liliaceæ*, an extensive and important natural order, which includes plants of very diverse appearance and use, as Hyacinths, Tulips, Onions, Aloes, Asparagus, Australian "Grass-Tree," etc. In 1861, three species of Yucca were cultivated in this country; that which is most frequently met with is the *Yucca gloriosa*, or "Adam's Thread and Needle," of which magnificent specimens were to be seen growing in the Crystal Palace grounds. The section before us shows various points well. It has been taken from a striped variety, if I read correctly the blanched look of the cell-contents at the angles of the leaf. The arrangement of the woody bundles will be noticed as interesting. Those next the surface furnish an example of "liber-fibre"; were it procurable in sufficient quantity a strong cordage might be made of this. A member of the family, the "New Zealand Flax," has of late years come prominently into notice as furnishing such a material, which is largely used in the manufacture of string. We have before us also a good example of thickening of cuticle by external cell-formation; sections of stomata, showing the openings and the cells which regulate the extent of aperture; of papillar cuticle; of raphides in situ, etc. etc.

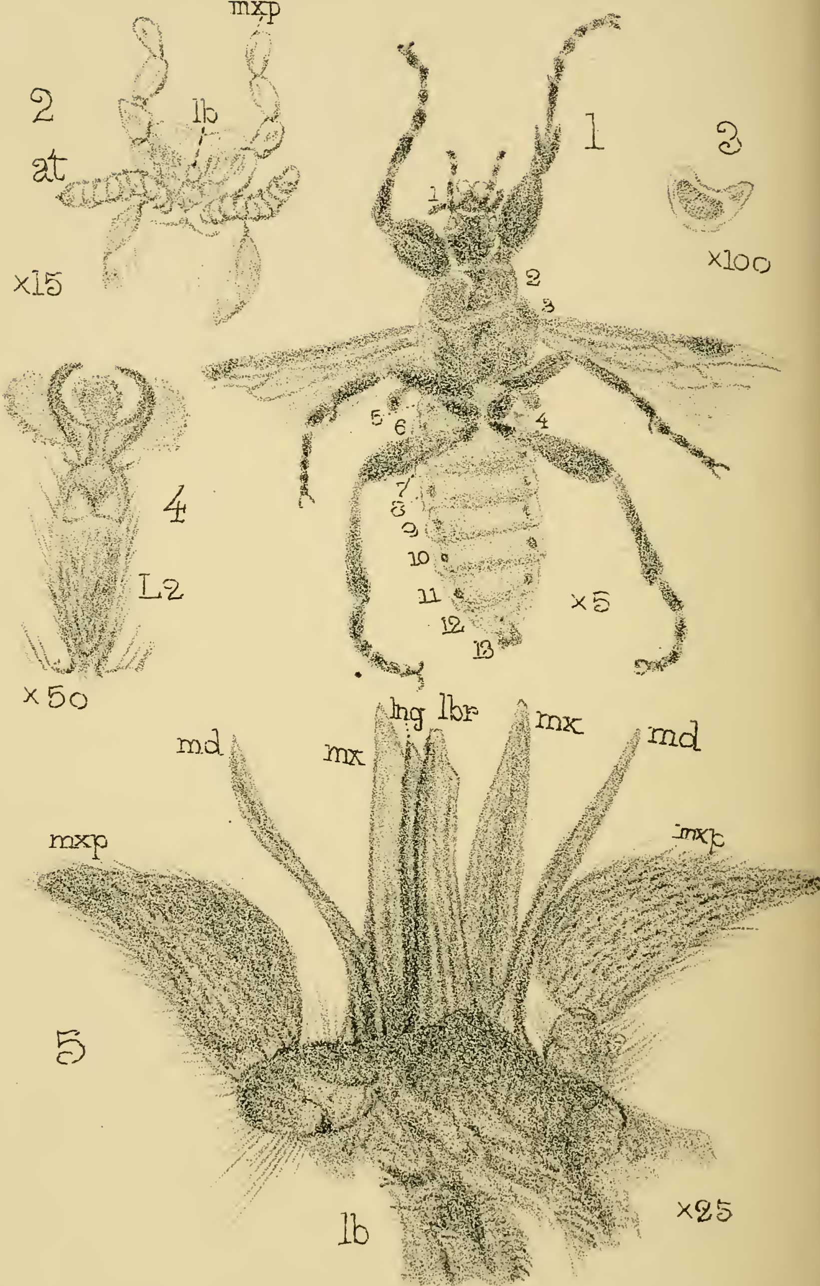
Clematis, trans. section (Pl. 27, Figs. 8, 9).—The species whence this section has been made is not stated; in the absence of information on the point we must suppose it to be from *C. vitalba*, the "Traveller's Joy," an elegant native, which luxuriates in chalky districts, and is especially beautiful, with its heads of feathery fruit in the winter-time, when all else is bare. It may be seen thus in its glory near Niton in the Isle of Wight; on the Hog's Back and Reigate Hill in Surrey, etc. Clematis belongs to the *Ranunculaceæ*. The section before us illustrates a condition not very common in plants,—the growth of a distinct layer of liber-fibres with every season. In many climbing-plants, it is common for the bark to split into layers, which hang in regular shreds. The Woodbine and Vine show this well; the tendency to do so is seen here. Also, the slight character of the medullary rays, whence is developed a tendency in the wood itself to split up into independent centres of growth, from which arise structures, the mode of whose formation it is often very difficult to explain. I wish that we had some members at Manchester, for I learn that the structure of "*Lianès*" has been followed up there with great success. A member afforded me the opportunity recently of examining one or two. The large openings are the ends of dotted ducts cut across; these ducts are remarkable for having slits across the pores. The cells of Clematis may be found in the autumn densely filled with starch.

Asterina gibbosa is the smallest of the British Star-fishes, and seems on that account to be a favourite with professional and other mounters. The tri-quadrifid spines fringing the edges have already been pointed out in connection with a similar slide, "*Solaster Papposa*" (see Vol. I., p. 147). The principal point of structural interest here shown is the Daccain-like coat-of-mail, due to imbrication of the scales on the lower surface. The upper portion of the animal has been removed, to admit of placing the specimen in a shallow cell. I had the pleasure last autumn of observing living examples of *Goniaster Templetoni*, a closely-allied form. These were in an admirably-arranged aquarium connected with the William Brown Museum at Liverpool.

Pediculus capitis (Pl. 28, Figs. 1, 2, etc.).—I can assure Dr. Moore (p. 122) that the two species, *P. capitis* and *P. vestimenti*, are truly distinct, and in the living state there is seldom much difficulty in saying which is which. The squareness of the head in *P. capitis* and the *black marginal band* are the most distinctive characters; the eggs, too, differ a good deal, both in form and in the place where they are deposited. A collection of these and other parasites, in connection with the Hospital for Skin Diseases, Blackfriars, is in course of formation, and will be placed there, it is hoped, shortly.

I have spent much time in the endeavour to make out the mouth, but am satisfied it requires the examination of living specimens, which I have not been able to procure. I have never seen any central pointed style; the nearest approach I have met with is represented in Pl. 28, Fig. 4. It is my present belief that the recurved teeth are the probable agents in opening veins—they will, of course, serve also to hold the mouth in apposition during the process of sucking. It was Nitzch who in 1818 placed the Mandibulate Lice with the Orthoptera; the Haustellate Lice


1
♀
×20
2
♂
×20
3
×200
4
×200
5
♀
×25
6
7
8
9
10
11


2
at
lb
mxp
x15
1
1
2
3
4
5
6
7
8
9
10
11
12
13
x5
3
x100
4
L2
x50
md
mx
lng
lbr
mx
md
mxp
mxp
5
lb
x25

(*Pediculus*, *Phthirius*, *Hæmatopinus*), with the Hemiptera. This was a decided step forward, but a more complete knowledge of the principles of classification shows that it should be considered only as a provisional one.

I have compared the specimen marked *P. vestimenti* with authentic specimens, and though I would not like to speak too positively, since preparation with potash and pressure alter appearances so much, my belief is quite that it is a specimen of *P. capitis*, ♂.

Bibio Marci, ♀ (Pl. 24, Figs. 1—4).—In examining the specimen labelled "Fly," to endeavour to make out what it is, we look first for the "halteres" ("balancers"); finding them, we are assured that it is really a Dipteron before us. The appearance of the wings is such that at first we really felt inclined to suppose it an Hemipteron. Having ascertained so much, the antennæ are examined. These are found to be composed of nine joints, cylindric perfoliated. It cannot, then, be a Gad-fly, but must be one of the *Tipulidæ*, a familiar example of which is the "*Daddy Long-legs*." The having the "fore-thighs thickened" is a character of the genus *Bibio;* in the sub-family *Bibionides*, the presence of the four-jointed palpi confirms this, and the neuration of the wings, in so far as can be made out, renders it probable that we are looking at a female of *Bibio Marci*. I do not know the habits of the creature sufficiently to be able to explain the purpose of the incrassated anterior femora and strong-spurred tibiæ. Walker's *Diptera Britannica* will be the best book to search for all that is known about it. There is a remarkable disparity in the appearance of the sexes in this genus; on the 15th of this month, scores of paired examples were to be found about here. This had been preceded by the appearance of great numbers of the males, with but here and there a female. This sight was only for a very brief period; now they have entirely disappeared, and I cannot procure a single example. An entomological friend tells me they only appear when the sun is shining at its brightest, and that with even a passing cloud they disappear entirely. The kidney-shaped spiracle is unusual. The Gad-flies have also a tri-lobed pulvillus, but the mouth shows at once that it cannot belong to that genus. I cannot here see a trace even of the "pseudo-tracheæ" so characteristic of the Dipterous proboscis. For comparison, I also give details of mouth of Gad-fly (Pl. 29, Fig. 5). A comparison of these with the structures found in *Bibio Marci* will illustrate the remarks made on the subject, and render further description unnecessary.

Aphis (Pl. 30, upper half).—The principal points shown in this preparation are the eye, the parts of the mouth, the limbs, and the contained ova. "As choke full of young uns as an egg is of meat," might fairly be said of it, so that, I think, it will hardly do to speak of *her* as a *he!* It is difficult to make out either the abdominal segments or the spiracles; the whole abdomen seems just converted into a bag of eggs. We subjoin a drawing of the chief points of interest.

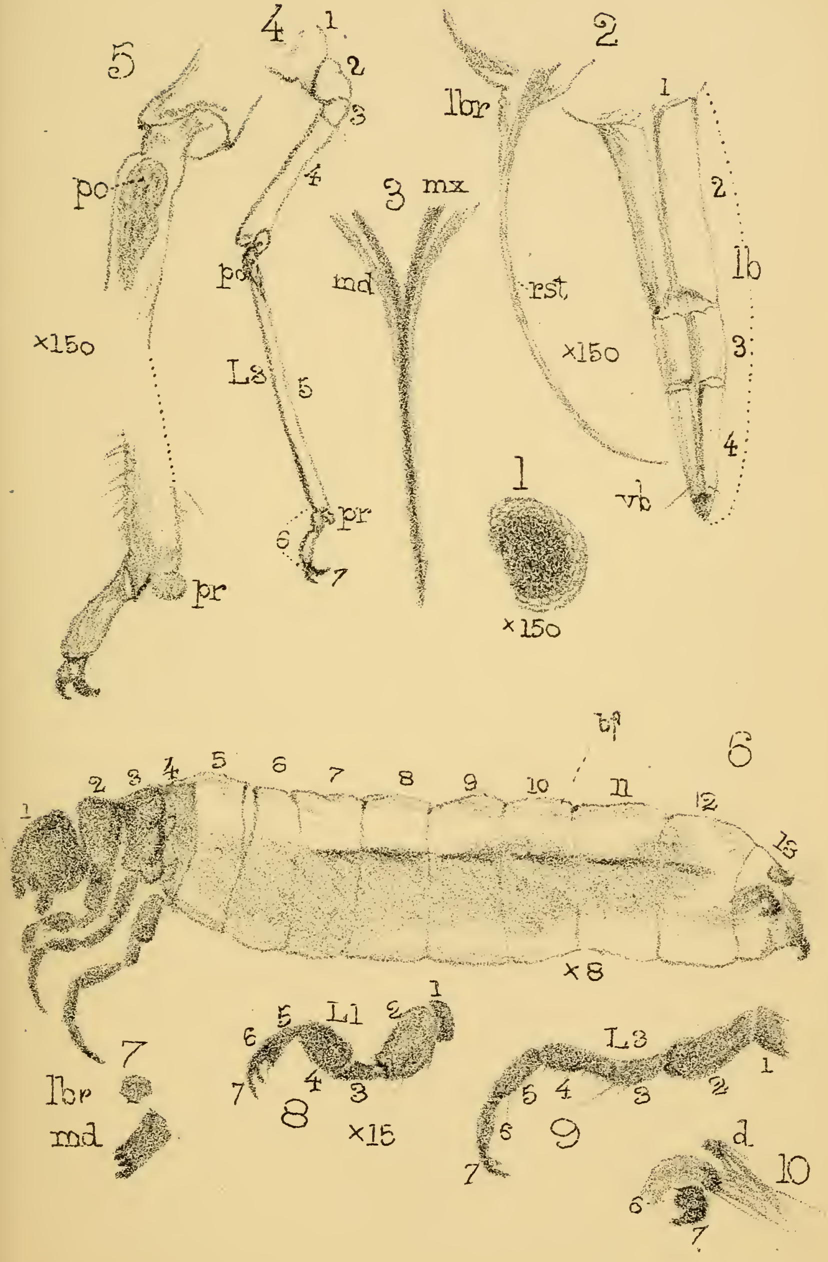
Larva of Caddis (Leptocera) (Plate 30, lower half).—The lucid notes on this slide (see page 124) render it superfluous for me to say anything further. So I shall merely add that Westwood gives a large amount of interesting detail on these forms. In *Science Gossip* for July, 1868, is a paper on their Cases by R. McLachlan, accompanied by various illustrations. At the same date appeared in *Popular Science Review* an article on the Flies and their larvæ by the Rev. W. H. Houghton; this gives a good general view of the subject.

There are notes on Caddis larvæ extracted from Rev. J. G. Wood's "Homes without Hands," in *Sci. Goss.*, 1866, p. 95, and on Caddis Worms by M. Pope in the same vol., p. 189. A very interesting paper with references to experiments by Miss Smee (*Pop. Sci. Review*, Jan., 1864) on cases built of different coloured materials. One of M. Pope's was of broken glass, beautifully translucent. Others on the same subject (I think by Helen E. Watney) have also appeared in *Sci. Goss.* The plan with red Coral is a capital notion. Too much stress must not be laid on species invariably building their cases of one kind of material; individuals occasionally employing (even in a state of nature) what comes nearest to them when engaged in their construction.

I should like to call the attention of our members to a communication in *Sci. Goss.* for July, 1867 (p. 167), in which the attacks of Caddis larvæ on small fishes would appear to have been attended with a venomous effect *; the subject is one which it would be desirable to examine further into. The materials composing the cases are attached by the assistance of silken threads, which they spin from the mouth in the same manner as caterpillars. The spinneret is said to be minute, and to be seated between the basal joints of the anterior pair of limbs, but further investigation into this seems to be required.

Acari from Chaffinch (Pl. 31, Figs. 1, 2).—These belong to a highly interesting group, the Itch-mites. One species,

* I have seen this happen in two instances this month, June, 1883.—E. T. Stubbs.



5
4
2
3
1
6
7
8
9
10
po
pr
×150
L2
md
mx
lbr
rst
lb
vb
×8
×15
L1
L3
md
d

Sarcoptes scabiei, is parasitic on man, causing a very painful pruriginous affection, well-known in some parts of the country by the familar name of "The Scotch Fiddle." Another species causes the affection called "Scab" in sheep; the name of this is "*Dermatodectes ovis*." It proves at times a terrible scourge. One species is found upon oxen, to which the name "*Symbiotes bovis*" has been given; it is nearly related to that before us, from the Chaffinch, but certainly distinct. Birds appear to be peculiarly subject to the attacks of these Itch-mites; it is common to find examples of two and three species on a bird, and I possess specimens of five different kinds from one bird.

TUFFEN WEST.

EXPLANATION OF PLATES XXVII., XXVIII., XXIX., XXX., XXXI.

PLATE XXVII.

Fig. 1.—Transverse section of Leaf of *Yucca recurva*. At the ends will be seen the absence of Chlorophyll, to which a white stripy appearance of the leaf will be due; in the centre a line of nourishing vessels, guarded by kidney-shaped bundles of woody tissue. With a higher power will be seen on the *upper* surface a good section of the dense cuticle, more highly magnified in

,, 2.—*Ct.*, cuticle; *sto.*, stomatal openings, guarded internally by stomatal cells, *stc.* About the middle of the lower surface of the section, a small portion of "ectoderm" has been broken away, whereby we obtain a view of

,, 3.—Stomata, *st.*, of the outline of the cells at this part, and of the papillæ, *p.*

,, 4.—The papillæ are seen projecting, *p.p.*

,, 6.—In a longitudinal section, raphid-bearing cells are to be seen, and cut across in the transverse section (Fig. 5).

,, 7.—A few long crystal prisms may also be seen.

,, 8.—Transverse section of *Clematis vitalba: ck.*, corky layers of bark; *l.f.*, liber-fibres; *p.*, pith; *m.r.*, *m.r.*, medullary rays = channels of communication between the central pith, and the outer growing structures; *d.*, ends of dotted ducts.

,, 9.—Portion more enlarged, showing corky layers of bark and liber-fibres.

Plate XXVIII.

Fig. 1.—Represents the female, *Pediculus capitis*.

,, 2.—The male of the same, in which it will be observed the limbs are both relatively and actually larger than in the female; the anterior pair are especially long and strong.

,, 3.—Parts of the mouth when not in use; a tube is seen capable of eversion, with certain backward-pointing hooks.

,, 4.—Part of the mouth everted.

,, 5.—*Pediculus vestimenti*, after Denny.

,, 6.—Anterior leg, *P. capitis*, ♀

,, 7.—Posterior leg of the same.

,, 8.—Antenna of same.

,, 9.—Ditto, *P. vestimenti.*

,, 10.—Posterior leg of the same, ♀

,, 11.—Anterior leg of ditto.

Plate XXIX.

Fig. 1.—*Bibio marci*, as seen with a low power; the small figures, 1—13, point to the segments composing the body.

,, 2.—Trophi: *at.*, antenna; *mx.p.*, maxillary palp; *lb.*, labium.

,, 3.—Spiracle of the sixth abdominal segment on the left side.

,, 4.—Foot of limb of the second pair, on the left side.

, 5.—Illustrates a dissection of the parts of the mouth in a Gad-fly "Stout": *lbr.*, labrum; *md.*, *md.*, mandibles; *mx.*, *mx.*, maxillæ; *mxp.*, *mxp.*, maxillary palpi; *lng.*, lingua (tongue); *lb.*, labium.

Plate XXX.—Upper Half.

Structural details of *Aphis* (? sp.) from *Cineraria.*

Fig. 1.—Eye.

,, 2.—"Trophi" (parts of the mouth): *lb.* is the labium, or under lip; it is formed of four joints, marked respectively 1, 2, 3, 4, and has at its termination a couple of tactile hairs, marked *vb.* (vibrissæ); a deep, narrow channel is seen in its length, in which the rostrum, *rst.*, is lodged; *lbr.* indicates the labrum, or upper lip. The rostrum is composed of four setæ.

,, 3.—Represents the rostrum from another preparation, partly in diagram. The two internal setæ are united, and appear to me to be modified *maxillæ—mx.*, or inner jaws; the mandibles, *md.*, play up and down in lateral grooves of the maxillæ.

These facts I have been able to make out in the cast skin of a small Hemipteron ("The Sage-fly").

Figs. 4 and 5.—Represent the joints composing a limb, *L3* = one of the third pair of the left side. At the knee-joint is a curious pulsating organ, *po.*, in Figs. 4 and 5—of course, only to be seen in living specimens; *pv.*, pulvillus, a sucker at the end of the tibia, whereby aphides are able to ascend smooth surfaces against gravity. In Fig. 4, the seven joints of the leg are numbered.

Lower Half.

Fig. 6.—Larva of Caddis-worm, *Leptocera.* The segments composing the body are indicated by the numbers 1—13 respectively. The mandibles are strong, obtuse at the tip, with several short teeth fitted for gnawing vegetable matters, of which the capacious stomach and intestines are seen to be full. The maxillæ and labium are rudimentary. The head exhibits no trace of antennæ; the eyes very small and difficult to see. *b.f.* supposed to be branchial filaments, but on examining living specimens, I find (*in them*) just a remarkable fringe of black hairs, separating the gills into two pairs seated above and below this line; of these gills I can see no trace in the mounted specimen.

,, 7.—*lbr.*, labrum; *md.*, mandible of left side.

,, 8, 9.—First and third limb of left side; 1—7, the joints composing the limb.

,, 10.—Hook of the left side = a rudimentary abdominal limb, attached to the last (13th) segment; *d.*, dorsal plate of this segment.

Plate XXXI.

Figs. 1 and 2.—Acari from Chaffinch, ♂ and ♀.

Fig. 3.—Organ of Sand-Wasp, (a copy of engraving in *Science Gossip*, referred to by Dr. George:)—*a.a.*, described as the double sting; *b.b.*, tubes; *c.*, sheath.

,, 4.—Foot of the same insect.

The above Plates, except where otherwise stated, are from drawings by Mr. Tuffen West.

Selected Notes from the Society's Note-Books.

GEOLOGICAL.

Section from the Ludlow Bone-Bed.—This bed was first discovered in 1840 by the late Sir R. Murchison, near the town of Ludlow, in Shropshire, where it consists of a single thin layer, some seven or eight inches thick, of brown bony fragments ; it is found lying near the junction of the Ludlow Rocks and the Old Red Sandstone.

The Ludlow Rocks form the higher series of the upper Silurian formation, and consist of finely laminated sandstone upper beds, and shaley mixed limestone lower beds.

On examining the section of this rock with the 1-in. objective, a confused mass of bony matter meets the eye, which on closer inspection shows each fragment of bone to have a rolled and rounded appearance. Several of the striated defences of the genus *Onchus*, one of the Shark tribe, are clearly discernable, the annexed being a rough representation. It would certainly be difficult from this specimen alone to determine the ownership of the various bones seen, as this can only be done after careful inspection of the bone cells, which are difficult to see in the present instance.

Fig. 21.

The rounded appearance of the bones leads one to conjecture, that some time elapsed before they reached their final resting place, and from the fine-grained tilestones which lie near this bone-bed, the resting place was at the bottom of a deep sea.

MANSFELDT H. MILLS.

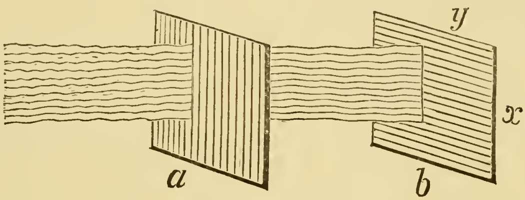
The Ludlow Fish-Bed has now been traced some 40 or 50 miles from Ludlow into Gloucestershire.

H. A. ROOME.

POLARISCOPIC.

Polarised Light.—The beauty of polarised objects causes the very frequent enquiry—"What is Polarised Light?" I cannot think of a better explanation than that given by stating that all beams of light are systems of waves vibrating in *different* planes. The polariser arranges these beams of light in sets; say in horizontal and perpendicular sets. And then each of these sets is absorbed or cut off by the subsequent crystals, if turned at right angles. This will be understood by the annexed Figure.

Fig. 22.



The gridiron *a* stops the horizontally disposed rays (or vibrations of rays); the gridiron *b* would allow the perpendicular vibrations to pass, if it were placed the other way up (if *x* were where *y* is); but having been revolved till it crosses the gridiron *a* at right angles, all vibrations are stopped.

It may interest those who use selenite to know that this was the material used by Tiberias Cæsar for glazing his greenhouse.

C. P. Coombs.

BOTANICAL.

Fig Tree, tr. sec. of a young shoot.—In this section crystals may be seen near the outer edge, but they are better shown in a longitudinal section; they appear to be somewhat cuboidal or lozenge shaped. I do not think they are Sphæraphides, although Dr. Gulliver mentions such as being found in the *Ficus*.

A. Cowen.

I think if Mrs. Cowen will examine her section of Fig-tree again with the ½-inch o. g. and polariscope *without* selenite, she will be better able to make out the crystals. There can be no doubt but that they are Sphæraphides, though somewhat indistinct. I have a leaf of the Fig-tree in my cabinet, in which these crystals are very abundant; still it does not follow that, because they are in the leaf, they must necessarily be in all parts of the plant or tree. Dr. Gulliver mentions several instances in which Raphides exist in the leaves, whilst short crystals are present in the "testa." Let me quote Dr. Gulliver's definition of Sphæraphides:—"Globulated forms made up of minute crystals or granules, and either smoothish, granular, or still rougher from projecting crystalline tips, and generally within a cell; the cells often forming a tissue like Mosaic work." Perhaps these crystals being so very minute, and having the projecting crystalline tips, have misled Mrs. C. into the belief that they are not Sphæraphides; but I think, if she will try again with careful focussing, she will be able to distinguish their character.

When examining any part of a plant other than the leaf, petal, or bulb-scale, &c., I adopt Dr. G.'s method, and first boil for a few seconds in caustic potash, and then smash it on a slide with the point of a knife. I have not in any case failed in finding the crystals,—let me add, *when there*. I believe there are some of the natural orders which have them not, though many of the genera of these great divisions have them. Our worthy President remarked on the *Euphorbiaceæ* as being mostly free from plant-crystals.

In *Science Gossip*, 1873, p. 97, will be found what I believe to be Dr. Gulliver's first published report of plant crystals. A shorter description appeared in the *Monthly Micro. Journal*, 1877.

H. Basevi.

For further detail see Vol. I. of this Journal, p. 152.

Editor.

ZOOLOGICAL.

Foraminifera from Silt.—During the progress of the works which have been carried on for some time at Sutton-Bridge Docks, my attention has been directed to the probability of the excavation yielding profitable material for microscopic enquiry; and although at present the examination by far abler microscopists has given no new forms, it has been a source of great interest to myself.

The Foraminifera were obtained at a depth of about 23 feet, and the section shows that except for a few inches of soil on the top, it consists entirely of SILT, and it is to the nature of this Silt (which is little known even to geologists or others out of this neighbourhood), that I purpose directing your attention.

Silt is very generally confounded with *Sand*, and chemically speaking they are very nearly the same, but in their physical properties Sand and Silt have but little resemblance. Sand, as is well known, becomes firm and hard under a covering of water; not so Silt; it flows nearly as readily as water itself. Sand is heavy and sinks rapidly in water, leaving it clean; whilst Silt floats in running water, and in still water it is deposited but slowly; the water continuing turbid for a long time.

Perhaps the readiest way to give a correct idea of its character would be to state that it is a deposit, (from a state of suspension in sea-water,) and that its component parts appear to be what may be termed, from its extreme fineness, "powdered sand," with an admixture of loam, and an uncertain percentage of shells, chiefly Foraminifera and Ostracoda, with a very small quantity of decayed vegetable matter. It should be observed that the presence of Foraminifera proves this Silt to be of marine origin, whereas Sand is often of fresh-water origin.

J. W. MEASURES.

Dr. Measures kindly forwarded to me about four ounces of this Silt for examination. I hastily "floated" the Silt to obtain the Foraminifera from it, and found it contained many.

The Silt is remarkably rich in species of Foraminifera as well as of the Ostracoda. Although the *quantity* of shells obtained from the four ounces of Silt is less than half a small teaspoonful, yet from considerably less than a tenth part of this quantity I have mounted a slide containing 48 species, from which I am induced to suppose that if a quarter of a hundredweight of the Silt was well dried and "floated," probably the number might be largely increased—perhaps doubled. It would be needful to collect from several localities a hundred yards or more apart.

This Silt is the most difficult to "float" for Foraminifera, of any similiar material I have yet had. There is something in it which will not settle in the water until days have elapsed. At the present moment, the water in which I floated my four ounces is still thick and muddy, although three days since I did it.

The following is a list of the Foraminifera, selected from the four ounces of Silt :—

Polymorphina compressa; P. oblonga, fine; *P. gibba; Polystomella crispa; P. striato-punctata*, fine; *Planorbulina Mediterranensis*, small; *Cornuspira foliacea; Nonionina depressula*, fine; *Discorbina rosacea*, fine; *D. globularis; Rotalia nitida; R. beccarii*, showing the disposition of this species to grow with spirals running to the right or to the left hand; *Truncatulina lobatula; Biloculina ringens; Bulimina purpoides; Tinoporus lucidus; Miliolina seminulum*, the *typical* Miliolina; *M. oblonga; M. subrotunda; M.* (? species); *Textularia globulosa*, very rare; *T. variabilis; Orbulina universa*, extremely minute; *Globigerina bulloides*, showing the deep umbilical vestibule, well; *Trochammina inflata*, fine, an arenaceous, brackish-water shell; *Bolivina plicata; Uvigerina angulosa; Nodosaria hispida; Patellina corrugata; Lagena sulcata*, the *typical* Lagena; *L. marginata; L. gracillima; L. lucida; L. Williamsonii; L. striata; L. melo; L. semi-striata; L. squamosa; L. hexagona*; one of these may be noticed of a scarlet colour, query, from the sarcode impregnating the whole shell; *L. lævis; L. caudata; Gromia* has a chitinous test, not calcareous.

CHAS. ELCOCK.

Foraminifera at Southport.—I was very much astonished when at Southport last month to see the quantities of Foraminifera abounding there in the little hollows between the ripple-marks on the sand. A bit of newspaper, gently pressed with the finger in one of these hollows, came up with no less than seventeen species sticking to it! With a teaspoon the shelly *debris* found in these hollows can be scraped up easily and rapidly, taking care not to go much below the surface—say, one-eighth of an inch or so. A quantity of this material, well washed in *fresh*- (not salt-) water, and then thoroughly dried and allowed to get cold, would probably "float" almost all the Foraminifera contained in it. The process of "floating" and preparing Foraminifera is thoroughly described in *The Journal of the P.M.S.*, Vol. I., pp. 26, etc.

To such of our Members as live on the sea-shore, a source of constant pleasure is open in the collection of Foraminifera, which may be found on the shore, in these ripple-waves or marks. I believe there is no shore on our coasts where they would not be found if searched for, especially at low tides; the lower the water the better. The soft oozy mud which abounds on some coasts is a favourite *habitat* for the Foraminifera, their delicate shells coming out beautifully clean and lustrous when washed out of the mud.

CHAS. ELCOCK.

Trichina spiralis.—In *Science for All* (October, 1878), Prof. F. R. Eaton Lowe, writing on the Chemistry of the Dinner-Table, says :—" The *Trichina* is a little creature, only the twenty-fifth part of an inch in length, but armed with terrible boring instruments, which enable it to pierce the firmest muscles, not excepting the heart itself. It propagates by millions, and passing through the walls of the intestines sets out on its migrations. It stops at nothing except bone, and insinuating itself into the substance of the muscles, spreads throughout the entire body. Some idea of their number may be gathered from the fact, that the body of an unfortunate German, who died a few years ago, was estimated to contain fifty millions. The Germans and Danes, from their habit of eating raw sausages and hams, are particularly liable to be trichinised, and notwithstanding the vigilance of the sanitary authorities in examining microscopically the hams sold, many persons still die or suffer from *trichinosis*."

T. Lisle.

Trichodectes scalaris is very common on Milch cows, and is therefore easily obtained; a good specimen makes a very beautiful slide. The difference between a *Trichodectes* and a *Hæmatopinus* may be readily seen by comparison.

C. F. George.

Hæmatopinus equi.—This species is not noticed in Denny's Monograph. I have specimens of *Hæmatopinus* both of the pig and ox, and although there is a general resemblance, there are certain small differences, so that it is undoubtedly a different species which infests the horse.

G. D. Brown.

I have compared this parasite with *Hæmatopinus* of the ox, swine, and ass, and although it does not exactly agree with either, it comes nearest to that of the ass, differing from it, however, in having much stouter legs; the abdomen and head, also, are rather different in shape. Speaking of the Ass-Louse (*H. asini)*, Denny says :—" This species is common upon the ass, frequenting the mane and back. I have also received specimens from the horse, from which circumstance I suspect it is the species described by Dr. Burmeister under the name of *Macrocephalus;* it is most certainly the insect figured by Redi. In a list of the species in the British Museum, communicated by J. G. Children, Esq., I find a manuscript name of *Caballi.* This I also suspect to be identical, from the fact of the *Asini* not being enumerated, and which, from its common occurrence, could not have escaped Dr. Leach's observation."

It would appear, therefore, desirable to make further comparison to determine whether there be a *Hæmatopinus* parasitic on the horse specifically different from that on the ass, although it is difficult to understand how (if it be so) it could have escaped Denny's observations.

WM. C. TAIT.

I have mounted several of the *Hæmatopinus* from the horse, and have known many horses to be troubled with this parasite, and have had my specimens alive. I have also had many *Hæmatopinus* from the pig, and although these two are somewhat alike, yet there is a vast difference when they are carefully compared. I have also *H. spinulosus* from the rat, *H. ventriculosus* from the rabbit, *H. eurysternus* from the ox, and one from the hare which I have not yet named. All these have a family resemblance, but when compared they are very different from each other.

C. F. GEORGE.

Pediculus capitis.—These lice are supposed to be a different species from *P. vestimenti*, of which we also have a slide in the box Pl. 28, Fig. 5. The characteristics of *P. vestimenti* are, the thorax contracted in front, and the abdomen with segments indistinctly indicated. I, personally, have never been able to see the distinction, and if the slide to which I allude is rightly named, it certainly is not very evident. In practice, however, we see Head-lice on clothes, and Clothes'-lice on heads, and as the difference is but slight, the difficulty of deciding which is which in any particular case, may account for my inability to recognise the species. There is also another *Pediculus* much like these—the *P. tabescentium*, which appears to burrow under the skin in certain diseased states, but this, I am happy to say, I have never seen. The *P. pubis* is another of the abominable insects that attack man, and is, I am sorry to say, somewhat common among the dirty lower classes. This, I see, is named *Phthirius inguinalis* in the *Micro. Dictionary*, 3rd. ed. There appears to be some doubt about classifying these insects. I used to be taught that they were HEMIPTEROUS insects, of the family *Rostrata;* now I find they are classed under the order ANOPLURA, which I think is an advantage. The haustellum, or rostrum, which they insert into the skin is somewhat of this shape (Fig. 23); the recurved hooks at its extremity being evidently intended to retain the sucker in the skin. I have never seen this myself and, indeed, it is said never to be seen except in action. It is described as being everted when required, somewhat, I imagine, like a snail's horn. "The males have at the extremity of the abdomen, which is rounded, a horny, conical, recurved, pointed spur, with which they can inflict a wound; this spur seems to be the sheath of the genital organ. In the female *Pediculus* the extremity of the abdomen is grooved, and during copulation she places herself on the back of the male." They multiply with frightful rapidity. "A louse has been known to produce fifty eggs in six days, and there were others still remaining in the body." Cleanliness is the best remedy for them, destroying the clothes and washing the head frequently with common yellow soap. The "nits" can be easily removed from the hair with a small-toothed comb, after washing with vinegar and water, or with spirits of wine. The young differ somewhat from the fully-formed insects in my experience, especially in the antennæ, the last three joints of which I have found united into one, the segments being only indistinctly indicated. I have never seen this mentioned. These insects cast their skin several times before arriving at their full growth. I possess a mounted specimen which was killed just as it was about to withdraw from its old skin. The animal evidently shrinks, and in my specimen all the parts appear in duplicate, so that it looks like a small *Pediculus* inside a larger one.

Fig. 23.

D. MOORE.

Pediculus vestimenti (Plate 28, Fig. 5).—This, I think, is identical with the Pig-louse, and readily distinguished from the Head-louse, the *P. vestimenti* having a neck, which the other has not, and the head is rounder.

A. NICHOLSON.

The drawing illustrating *P. vestimenti* is copied from Denny's "Monographia Anoplurorum."

EDITOR.

Larva of Caddis-fly (Leptocerus).—This aquatic larva is one of the case-bearers, and from their earliest infancy one of their most important duties of life is the formation of their house, which in some species is composed of pieces of stick, in others of sand and small stones, in others of the living stems, bitten off aquatic plants, in others small Planorbis and other shells, and in countries where precious stones are not uncommon in the river beds, a species of this curious larva has been found in a truly gorgeous house composed of amethysts. I have found these cases sometimes where the larva has taken a fancy to a rather large piece of wood, and cemented it to his growing house, and it has been just as much as Mr. Caddis could manage to drag his house along; it not unfrequently occurs, that a young Planorbis finds he has been used as part of a caddis-worm's case, and is an unwilling companion in all his rambles. In a brook which I have often examined, all the aquatic insects had this one fault (if such it may be called), that their exposed cases, or backs, were coated with stone; the water deposited carbonate of lime very rapidly, and all the Caddis-worm cases in this brook were so strongly encased in this stony covering, that they looked for all the world like animated fossils; the various water-snails, scorpions, &c., were all more or less coated with this deposit, as were also the nuts and oak galls that fell into the stream.

It would be a boon to microscopists if they could ascertain the recipe for the Caddis-worm's cement, which fastens stick, stone, and shell tightly together under water. If we can procure any of the young larvæ, it is not difficult to make them build their homes of any materials we wish, by merely supplying them with it and no other material. In this way very good and interesting specimens for the cabinet may be obtained. A case formed of bits of red coral would form a very beautiful natural-history object.

Phryganea flavicornis composes its case of large pieces of wood, *P. rhombica*, of sprigs of aquatic plants, and *P. fusca* uses stones, straws, &c. &c., in the construction of its case.

ED. LOVETT.

Odynerus, posterior portion of Abdomen of.—In "Science Gossip," Sept., 1868, p. 205, there occurs a drawing with some remarks by S. S. on *Odynerus parietum*, describing the sting as double in this creature. I have made some few observations on *O. parietum*, have watched it to its nest, extracted the small caterpillars collected for the support of its young, and finally have caught and dissected the unfortunate insect, but did not find its sting double; but last summer, when out collecting, I caught a species of *Odynerus* possessing what at first I supposed to

1

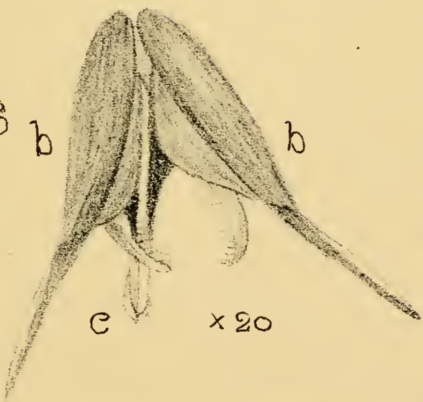
♀

× 75

2

♂

3



4

× 50

be a double sting. On examining its antennæ, I found them hooked; this is a characteristic of the male. I at once saw that S. S. had been describing the male organ of *Odynerus*; but still I do not understand his article, for he describes and figures the poison bag; and of course no such organ exists, so far as I know, in the male *Odynerus* any more than it does in the drone, or male hornet, or other wasps. I was preparing this double sting for the microscope, when, in removing it from a piece of glass (on which it had dried), I lost it, much to my chagrin, for the males of *Odynerus* are not very common—at least, I have not been fortunate enough to fall in with them frequently; however, one day I found a male *Odynerus* dead on the window, and therefore at once tried to mount this portion of the creature. I have not seen any notice of this peculiar formation anywhere but in *Science Gossip;* will our readers tell us all they know on the subject? I may just say that the two *Odyneri* I have mentioned were different varieties.

C. F. GEORGE.

We have copied the drawing of this remarkable organ, which Dr. George proves to belong to the male, *Odynerus*, from the Vol. of *Science Gossip*, above referred to; it will be found on Plate 31, Fig. 3.

EDITOR.

Ciliary Processes in the Eye of an Ox.—A thin vascular membrane called the *Choroid* lies between the *Sclerotic* coat of the eye and the *Retina* (or expansion of the nerve of sight). At one part of the choroid is a series of folds separated from one another by deep furrows; these folds are the *Ciliary Processes.* In the human eye they number 70 to 80; they have the appearance of a regularly plaited frill, and are very richly supplied with blood-vessels.

H. A. ROOME.

Reviews.

THE SCIENTIFIC ROLL and Magazine of Systematized Notes. Parts 1 to 11, May, 1883. Conducted by Alexander Ramsay, F.G.S. (*J. H. Fennell*, *7. Red Lion Court*, *Fleet St.*, *London.*)

The main purposes of this Journal are to facilitate research, and to afford a medium by means of which scientific enquirers may help each other. This is afforded by broadly classifying the sciences, and grouping the various items under specified headings.

The Journal commences with Meteorology, the first six numbers of which relate to Climate generally; the rest are devoted to Aqueous Vapour, including Humidity, Dewpoint, Clouds, Fogs, Mists, etc.

The labour of compiling the Scientific Roll must be immense, but Mr. Ramsay appears to be carrying it through with great success; the numbers up to date are replete with interesting matter.

Ants and their Ways. By the Rev. W. Farren White, M.A., M.E.S.L., Vicar of Stonehouse. *(London: Religious Tract Society.)*

This charming book gives a most interesting account of the manners and customs of those "little people," "which are exceeding wise."

The author very pleasantly describes, not only a great number of English, but many also of the foreign species—*e.g.*, the Honey-Ants of Mexico and Colorado, the Harvesting-Ants of the South of France, the Agricultural Ants of Texas. The book is illustrated with 43 nicely-executed engravings.

An appendix is added, in which is given a complete list of the Genera and Species of all the British Ants.

The Practical Naturalist, devoted to the assistance and encouragement of lovers of Nature. Parts 1—6, June, 1883. Edited by H. S. Ward and H. J. Riley. (*W. P. Collins*, *London*, *and John Heywood*, *Manchester*.)

This is a new Natural-History Journal, consisting of 12 pages, and its price is one penny. The articles are well written, and we trust that our young friends will afford to it the encouragement it deserves. We are pleased to notice that the editors have formed among their youthful readers a "Practical Naturalists' Society." We wish the Journal and the Society every success.

Portfolio of Drawings and Description of Living Organisms, Illustrative of Fresh-Water and Marine Life. By Thomas Bolton, F.R.M.S. Part 9, March, 1883.

This Portfolio contains drawings and descriptions of sixteen organisms belonging to the animal kingdom, viz.—Uvella virescens, Pyxicola affinis, Stichotricha remex, Trochosphere of Alcyonidium, Œcistes umbella, Cephalosiphon limnias, Melicerta tyro, Floscularia regalis, Annuræa curvicornis, Leptodora (young stages), Idya furcata, Haplobranchus æstuarinus, Ammothea fibulifera, Water-mite (Atax albidus), Water-mite (Nesea, ? sp.), Elver, or young eel.

BRAMPTON'S SPRING BINDER forms a very suitable case for holding a complete set of the Portfolios.

HINTS ON THE PRESERVATION OF LIVING OBJECTS and their Examination under the Microscope, by Thomas Bolton, F.R.M.S., is a useful little pamphlet. It contains instructions for the examination of objects attached to Weeds, Free-Swimming Rotifers, Infusoria, etc.

THE MICROSCOPE AND SOME OF THE WONDERS IT REVEALS. By Rev. W. Houghton, M.A., F.L.S. Fourth edition. (*Cassell, Petter, Galpin, & Co., London.*)

This is a handy little book for a beginner in microscopical study. It is divided into twelve chapters. The first treats of the microscope generally, and is followed by others on the various applications of the instrument in Botany, Zoology, and Geology, and finishes with a chapter on the Collecting and Mounting of Objects, Test Fluids, etc. It is illustrated by 46 wood engravings.

OLIVER WENDELL HOLMES; POET, LITTÉRATEUR, AND SCIENTIST. By William Sloane Kennedy. Cr. 8vo., 1883. (*Boston: S. E. Cassino and Co.; London: Trubner and Co.*)

The biography of a man of science is always attractive. The one before us is by no means the least interesting of those we have read. "This volume," we quote from the preface, "does not profess to be a biography in the strictly technical sense (may the time for such an undertaking be long deferred), but it is designed to serve as a treasury of information concerning the ancestry, childhood, college life, professional and literary career, and social surroundings of him of whom it treats."

With O. W. Holmes as a Poet and Littérateur it is not our province to deal; but as a SCIENTIST we find he has done no mean amount of work. After making many experiments in the construction of Microscopes, Prof. Holmes succeeded in inventing one which quite suited his requirements. Vol. II. of the *Proceedings of the American Academy* contains a communication from him "On the use of Direct Light in Microscopical Researches," accompanied by a drawing of a horizontal microscopical apparatus invented by himself.

Homœopathy is a science in which he evidently does not believe, judging from the extracts which are given of two "brilliant lectures." Three years after writing these he startled the physicians of Boston with almost as severe an attack upon Allopathy. The volume concludes with a full bibliography of the writings of Dr. Holmes, up to date, including his contributions to periodical literature.

Perhaps we cannot better conclude this short notice than by quoting Oliver Wendell Holmes' own words :—"It is an ungenerous silence which leaves all the fair words of honestly-earned praise to the writers of obituary notices and the marble workers." The book is beautifully printed on good paper and well bound.

THE UNTOWARD EFFECTS OF DRUGS: A Pharmacological and Clinical Manual. By Dr. L. Lewin, of Berlin. Second Edition, revised and enlarged. Translated by J. J. Mulheron, M.D. (*Geo. T. Davis, Detroit, Mich., U.S.A.*, 1883.) The only English translation having the author's endorsement.

This book, consisting of about 220 pp., is intended for the study of the medical professor. It is sufficient to state that in this work all the drugs in general use are, without exception, investigated with reference to their untoward effects. The physician will not lay down the book without having received from it some important information, and will doubtless be incited to further observation.

THE MICROSCOPE and its relation to Medicine and Pharmacy. Edited and published by Chas. H. Stowell, M.D., and Louisa Reed Stowell, M.S. (*Ann Arbor, Mich., America.*) Vol. 3, No. 1. April, 1883.

We have only time and space briefly to notice this very excellent bi-monthly. A hasty glance assures us that it is a well-written and exceedingly interesting Journal. The first article is on "A Parasite on or in the Red Blood Corpuscles of a Terrapin," illustrated by a lithographic plate in two colours, in which the worm-like parasite is shown, at times on, at others apparently in, the blood corpuscle. The other papers are all well written and very readable, and on the whole we are much pleased with the Journal. We must heartily congratulate the editor (Dr. Stowell)—1st, on his recovery from a protracted and serious illness; and 2nd, on the very able and efficient manner in which his co-editor (Mrs. Stowell) has conducted the Journal during his illness.

THE MEDICAL REGISTER: A Monthly Record of the Literature of Medicine and the Allied Sciences. Vol. 2, Nos. 2 and 3. April and May, 1883. (*P. Blakiston, Son, & Co, Philadelphia.*)

Contains, in addition to several good articles, Critical Reviews, Book-notices, Miscellaneous News, and a very full Bibliographical List of all New Books published on Medical and relative subjects.

A Popular Treatise on THE HAIR: ITS GROWTH, CARE, DISEASES, AND THEIR TREATMENT. By C. Henri Leonard, M.A., M.D. Fifth thousand. (*Geo. S. Davis, Detroit, Mich., U.S.A.*) Illustrated by 116 engravings.

The first five or six chapters of this book are of much interest to the microscopist. They treat of the Anatomy and Physiology of the Hair and Hair Follicles, of the Hair Root, and of the Hair Shaft. The remaining chapters (28 in all) will doubtless prove interesting to the general reader, if not to the microscopist. The various diseases of the Hair are discussed, and receipts given for their treatment.

Current Notices and Memoranda.

THE Editor regrets that owing to a severe illness the issue of the present part has been unavoidably delayed.

We are advised by our Publishers to issue Parts 7 and 8 together on 1st October. By so doing we shall be able to complete each volume at the termination of the Society's financial year. This double part will consist of at least 128 pages and 12 lithographic plates.

Bacillaria paradoxa.—Mr. R. T. Homan, of Rochester, writes: —Last year I found this diatom in several places in this neighbourhood. One was a small ditch which is frequently flooded with salt water from the River Medway; but I have found it in much greater abundance in a ditch supplied by a meadow stream of perfectly fresh water.

Mimicry in Fungi.—"Instances of mimicry are not rare amongst fungi. They are more frequently attractive than protective mimicries. They may be of vegetable, of animal, or of excrementitious substances, either as regards external appearance, or as regards colour. The main object of these mimicries is the attraction of insects, the advantages of which to plants are:—(1) either fertilisation of hymenomycetous spores by co-specific spermatia from other individuals, or by the transportation of spores from the hymenium of one fungus to that of another, or perhaps increased germinative energy to the spores is obtained by the admixture of other co-specific spores without the element of sexuality; (2) the diffusion of the fungus spores by insects as well as by the larger animals."

Grevillea.

The Practical Naturalist for May contains the first of what promises to be a series of good papers, entitled "Hints for Museum Curators." No. 1 gives some practical hints on Preservatives, Tools, &c.

The American Naturalist fully maintains its character. Amongst the papers of more than common interest to the Microscopist are:—The Development of the Male Prothallium of the Field Horsetail, illustrated with two plates; Heterogenetic Development in Diaptomus, illustrated with three plates of fresh water Entomostraca; Remarks on the Morphology of Arteries, especially those of the Limbs, illustrated with four plates, three of which are coloured; Pitcher Plants, &c. &c.

We notice that two new departments have been added to the *Naturalist* this year, and that some 36 pages have been added to each monthly part.

"Wherever Science looks with close and careful eyes, life appears to be found. The deepest sea-soundings reveal the existence of cephalopods, brittle stars, or lower genera; the upper waters are full of invisible creatures; the dust of the air is laden with germs and infusoria, and there is no part of any living bodies but seems to be peopled with countless parasitical dwellers. It is a little surprising, however, to be told that the decaying bricks of all our buildings in London and elsewhere are densely inhabited by special animalculæ. This, however, is positively announced by M. Parize, who declares himself to have seen with the microscope, in every portion of crumbling, weather-worn brick-work, minute living organisms, which are the real destroyers of the surface and even the walls of buildings. The harder the brick the fewer these tiny burrowing things would be; but wherever the walls are seen to be 'weathered' there they are declared to exist, making their invisible lodgings in the material which would seem so impervious. We do not answer for the accuracy of these observations, but they cannot be called ridiculous when it is remembered that the sea-worm eats through stone and shells; and that even tobacco-leaves are bored by creatures which feed on them and dwell in them. That these odd beings can get nourishment from a bath-brick or a cornice cannot be imagined; but, if they really inhabit our walls, as is said, one more proof is given of the ubiquity and wonderful variety of life."—*Daily Telegraph.*

"If a leading journal of the great Pacific State be correctly informed, our architectural little friend, the busy bee, is at the present moment in imminent danger of forfeiting, through no fault of its own, the monopoly of making honey with which it was supposed to have been exclusively endowed by nature. It will doubtless continue, as from time immemorial, to gather that delicacy all the day from every opening flower; but it will no longer be the only insect privileged to improve each shining hour in that particular manner. An American naturalist, named McCook, is said to have just discovered, somewhere in Mexico, a species of ant in every respect qualified to compete with the apian industrial upon whom we have hitherto been dependent for our honey supply. Our Western contemporary states that the Philadelphian Academy of Sciences has already published a full description of the ant in question, christened by its discoverer 'Melliger,' representing it as large of its kind, and provided with an abdominal pouch which, when filled with honey, swells to the size of a tiny grape. The Mexicans, it would appear, collect this honey for consumption and sale by squeezing its ingenious little fabricators to death in presses, many thousands at a time. According to McCook, nine hundred and sixty 'Melligers' yield exactly one pound of honey, fully equalling in fragrance and lusciousness the product of Dr. Watts' familiar exemplar of the minor virtues."

An interesting account of the Honey-making Ants will be found in "Ants and their Ways."

Those Ants without stings, with single nodes or scales, and three ocelli, and whose larvæ spin for themselves cocoons, are called *Formicidæ;* while those possessing stings, two nodes, and whose workers want ocelli, and whose chrysalids are naked, are called *Myrmicidæ*. Of the *Formicidæ*, there are, including the Madeira ant, *Tapinoma gracilescens*, which I found at St. Mary Aldermary Rectory, fourteen species; and of the *Myrmicidæ*, including the Madeira ant, *Pheidole lævigata*, which I discovered in the baker's shop in the Borough, seventeen species.

* * * * *

There is a third nationality or family of the little people, the *Poneridæ*, forming a connecting link between the *Formicidæ* and the *Myrmicidæ;* for while they have only one node—which is raised to a level with the first ring of the abdomen, which latter is always more or less constricted—they have their females and workers furnished with stings, and the larvæ spin for themselves cocoons. These are represented by two rare species—the *Ponera contracta* and *Ponera punctatissima*.

"*Ants and their Ways*."

Wanted.—Parts 4 and 6 of Vol. I., 1878, JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY. Will give in exchange Vol. I. (bound) of the Journal of the POSTAL MICROSCOPICAL SOCIETY, or the year's parts of Vol. II., as published.

Address EDITOR, 1, Cambridge Place, Bath.

Exchange.—I offer Fossil Sand from Saucat's tertiary deposits, containing well-preserved **Foraminifera, Shells, Corals, & Spicules** (any quantity), in exchange for good mounted slides.

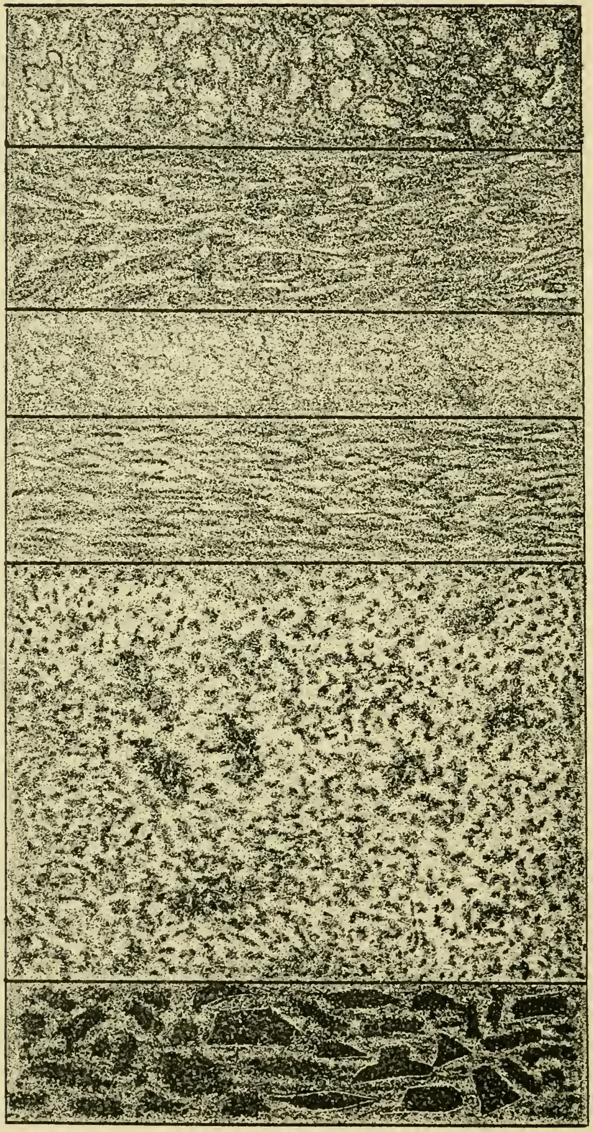
E. RODIER,

61, Rue Mazarin, Bordeaux, France.

Exchange.—I offer **Fossil Diatoms** from Franzenbad, in Bohemia, and from Celle, in Hanover (any quantity), in exchange for good Micro-material or Mounted Slides.

J. C. RINNBÖCK,

14, Simmering, near Vienna, Austria.


1
2
3
4
5
6

The Journal

OF THE

Postal Microscopical Society.

OCTOBER, 1883.

Organisms from the Recently-Discovered (Ancient) Roman Baths in Bath.

By R. H. Moore.

Plate 32.

A Paper read to the Members of the Bath Microscopical Society, May, 1883.*

IN the Roman Bath recently laid open to the city, the greater interest has centred in its archæological character; the lesser interest I am desirous to evoke. As we gaze upon its noble fragments of architectural columns, its broken altar, its fine series of steps, and its substantial ambulatory, the imagination pictures former scenes of activity and enjoyment among an intruding race of men, which is in marked contrast with the present desertion and ruin of this once-favoured spot. But so soon as desertion commenced and decay became apparent, Nature's deft fingers supplied the vacuum, and amid the ruins of man's industry she

* This paper was in type and the plate prepared in time for the July part, but pressed out for want of room. We were surprised to notice that a somewhat mutilated copy appeared in a contemporary.—Ed.

grasped the situation, and the site which had been busy with the haunts of man, and cheerful with the hum of conversational delight, became a world of tiny molluscs and waving rushes, land and water teeming with real but less apparent life. The relics of this subsequent life I am desirous to bring before our readers.

During the excavations on the site of the Roman Bath last year, our fellow member, Mr. Bartrum, who was then Mayor of the city, introduced me to a bank of mud resting upon the floor of the bath, and situated immediately under the Poor-Law Offices. From this bank of firm mud the organisms which form the subject of the present paper were selected. It was from eight to nine feet deep, as shown in the accompanying plate, and made up of clearly-defined strata. At the bottom, upon the floor of the bath, lay the broken Roman tiles which once covered its roof, and thus, all that was found above them must have been the accumulations of the centuries which intervened between the departure of the Romans and the decay of their noble work, and the more modern times when buildings became erected on the identical, but owing to the deposits, on the more elevated site. Above the tiles came a bank of firm black mud from five to six feet in depth, filled with thousands of fresh-water shells, their white forms contrasting with the dark earth so strikingly, that even to an ordinary observer, the bank was very attractive. Above this mud a stratum of vegetable deposit was found about two feet thick, black in colour, and moist and flaky in character. Another curious mass of vegetation lay upon the latter, greenish in colour, and light in weight, and, under the microscope, it was found to be principally composed of hollow fragments of a cylindrical shape. Above this stratum a mass of wood was found embedded in mud and sand, but as no rootlets were found, the gentlemen who surveyed the spot considered that these were originally bundles of hazel-wood, thrown upon the marshy ground to form a foundation for the subsequent buildings which became erected upon the spot. Each of the branches was pressed out of the usual cylindrical into an oval shape, and was of a very soft and moist character. The whole mass of wood had evidently been used as fascines. Above this stratum the foundations of the present buildings commenced.

The Roman occupation of Bath probably ranged from A.D. 50

to A.D. 440. Coins have been found with Nero's superscription, and also with those of Trajan and Hadrian, in various portions of our city. Wright, in his Bath Guide, states that probably A.D. 45 witnessed the arrival of a detachment of the 2nd. legion to be stationed in this city, and he further states that in A.D. 120, Hadrian crossed over to Britain with the 9th. legion, and installed a detachment of Roman soldiers in Bath. He alleges that the social and military works of the Roman conquerors were probably completed in A.D. 50, after two or three years' arduous labour, and he especially refers to the splendid Roman baths, 20 feet below the present level of the city, as among the constructed works of that date. After the evacuation of the city by the Romans, the noble handiwork of these foreigners probably remained until A.D. 577, when the Britons were overthrown by their Saxon conquerors, and it is interesting to trace the subsequent character of the site, which only last year was so rich in organic remains, but which remains have been carted away to form a soil in some portions of the Royal Institution Gardens. After corresponding with Dr. Partridge, of the Stroud Microscopical Society, that gentleman visited the site of the bath, and received from me a section of the mud bank. He thereupon consulted Mr. Witchell, of Stroud, a Fellow of the Geological Society, and his report upon the character of the site and the nature of the deposit is as follows:—

"In the deposits which immediately overlie the Roman tiles, the physical condition of the valley of the Avon, following the period of the Roman occupation, is clearly shown. It appears, that on the departure of the Romans the country lapsed into its primitive state; the bed of the river, no longer kept in order, became dammed up by fallen trees, landslips, and the like, and the place where a high civilisation had existed became a shallow lake. The torrential streams of winter washed down from the neighbouring hills the surface-mould and decaying vegetation into the bottom of the valley, where it became deposited as mud, of which it formed successive layers mixed with the river-sediment and fresh-water shells. As a considerable portion of the strata of the hills around Bath consists of 'Fuller's earth,' it is probable that much of the firm mud, which appears to be from 5 to 6 feet thick, was derived from the washing, by rain, of the 'Fuller's earth' slopes. The continuance of this deposit was certainly prolonged, as the quantity of matter deposited in any single year must be represented, in its now compressed form, by a very thin layer. Eventually these deposits ceased, and then the surface became adapted for the growth of rushes; in fact it became a morass, and this condition of things prevailed long enough to allow of the deposit of decayed rushes to the depth of two feet. At the close of this period the river bed appears to have been cleared of its obstructions, probably by the hand of man, as the bed overlying the rush deposit is of artificial origin. The works of civilisation were again resumed, and the surface of the river valley underwent a corresponding change.

"It is difficult, without personal examination, to describe with accuracy the physical changes that took place, and which led to the formation of these deposits; but in all the river-valleys of this part of the country, where the current is not very rapid, there must occur in the natural condition of things, obstructions of the nature of those I have suggested as having occurred at Bath. In the valley of Frome, near Stroud, there are many flat meadows which owe their origin to similar conditions. The section is interesting, inasmuch as it shows that a state of change still exists, that the operations of nature, under which the surface of the high lands is being denuded, are still going on, and where, as in the present instance, some of the results are capable of measurement, they are shown to be neither slight nor unimportant."

Beyond this opinion a large amount of interest centres in the probability, that at one time the tide flowed up the river as far as the site of the bath.* I am greatly indebted to Mr. Rimmer, F.L.S., of London, whose recent, admirable book on "The Land and Fresh-Water Shells of the British Isles," enabled me to correspond with him. He has not only been kind enough to complete the naming of the shells, which I shall presently describe, but he calls attention to one species found, not in the mud bank, but mixed with the sand and soil of the ambulatory in great abundance. This species is known to inhabit only brackish water, and besides these shells, some diatoms which I have found

* This must have been impossible on account of the great difference in level between Bath and the highest tidal point of the Avon.—Ed.

in the mud bank are really other than fresh-water species. Mr. Rimmer writes thus:—" The question, which is a very interesting one, arises as to how these molluscs, '*Hydrobia ventrosa*,' came to be in a spot so far removed from 'brackish water,' their well known proper habitat. My idea is, that at some period the tide must have flowed up the Avon as high, or perhaps higher, than the city, and that in course of time an accumulation of *débris* carried down by the stream, gradually formed a barrier, which slowly but effectually checked its progress. Other causes, however, may have been at work; in any case, the subject is, I think, quite worthy of the attention of your local geologists." It now only remains for me to speak of the contents of the mud bank I have described.

The MOLLUSCA form a sub-kingdom of the animal world, divided into—1. **Acephalous,** without a head; 2. **Cephalic,** having a head. The former division have Bivalve, the latter Univalve shells; of the latter only I have to speak, because I have discovered no bivalve shells in the deposit of the bath. The Cephalic molluscs, Mr. Rimmer writes, "are of a higher organism than the *Acephela*. Their nervous system is more fully developed, they have a distinct head, and usually tentacles or feelers, on the tips, or sometimes at the base of which the eyes are placed. In some cases, however, the animals are eyeless." It is not my purpose to enter into their physiological structure, as this paper is only intended to describe certain forms which are found in the mud bank. Cephalic molluscs inhabit both marine and fresh-water; they live on land, or they may be amphibious. This description brings us to another division, which is confined to those molluscs that dwell on land or inhabit fresh-water, and is termed GASTEROPODA; here we are introduced to two orders, named *Pectinibranchiata* and *Pulmonobranchiata*, according to their breathing organs. The aperture of many of the univalve shells is closed by a curious appendage, termed the operculum, which is attached to the foot of the creature by a strong muscle. The shells in this stratum belong exclusively to the *Gasteropoda;* and, among the first order, *Pectinibranchiata*, there are a very few which belong to the first family of the *Neritidæ*. (I have only found four.) There is only one British genus in this family, *Neritina*, and only one species, *N. fluviatilis*. I have mounted three specimens, together with the operculum, which is peculiar in having on its under side a projection, which seems to keep it in a proper position. The shell is prettily marked with purple bands, and the broad character of the inner lip is very noticeable. This mollusc inhabits rivers and lakes. The female deposits her capsules, containing from forty-five to sixty eggs, upon the shells of neighbouring molluscs. In the second family of this order, *Paludinidæ*, most of the shells in the deposit are found to belong to Genus 2, *Bythinia*, species *B. tentaculata*. In the living creature the tentacles are filiform, and the shells, when thoroughly cleansed, are beautifully transparent. The deposit is full of their opercula which have become separated from the shells, and in themselves are very pretty with their concentric markings, being, in fact, plates of growth in different stages of the creature's existence, deposited one over another. This mollusc is very common and very timid, retreating into its shell with the slightest touch. It floats under the water, and deposits its eggs, 10 to 70 in number, on stones or on aquatic plants. In the third family, *Valvatidæ*, no specimen is found in my collection.

In the second order, *Pulmonobranchiata*, there is a large number of specimens from the family *Limnæidæ*. In the first genus, *Planorbis*, Mr. Rimmer has named for me the small and really microscopic species, *P. nautileus*. I think it is the gem of the collection when viewed under a low power, its markings bearing a striking resemblance to the beautiful curves and ridges of the well-known *Nautilus* which have originated its specific name. Another species of this family, in my collection, is *P. complanatus*, a discoid shell of much larger size. Both species are shy and irritable, attaching themselves to aquatic plants, and dropping from their attachments instantly if touched, retreating at the same time safely within their shells, which are considerably larger than the body of the animal they protect.

In the third genus, *Limnæa*, Mr. Rimmer has named for me *L. peregra*, a species found very abundantly in the collection, both in its young and mature stages. This mollusc inhabits ponds and ditches, climbing the stems and leaves of plants above water-mark, and is fond of wandering. It is also very predatory, and has been known to attack and eat minnows, and even other molluscs of its own species. In Mr. Rimmer's book its prolific character is proved by the fact that a single creature has been known to deposit 1,300 eggs in one season. There is one other shell in the collection which Mr. Rimmer has also named for me, and this is a single specimen of land-shell, *Pupa umbilicata*. It belongs to the third family of terrestrial shells, termed *Helicidæ*, and the sixth genus of that family. It inhabits the crevices of walls, or lives under stones and fallen leaves. This species is ovo-viviparous, and the young, which seldom exceed 5 in number, often remain for a time attached to the shell of the parent. The shell of immature specimens of this mollusc is frequently so unlike that of the adult, that it may be mistaken for a distinct species. The only remaining shells that I have discovered, are those which I have already referred to as belonging to brackish water, *Hydrobia ventrosa*. They are very pretty, and were found on the outside of the bath, and not in the mud bank, but I found them in very considerable quantities. The mud itself, after boiling in acids, has yielded a fair proportion of Diatom valves :—*Cocconeis placentula*, *Navicula*, *Pinnularia viridis*, and *Cyclotella*, etc. : all of which are fresh-water species, but I have also found fragments of *Coscinodiscus*, which are only marine, and on one of the slides prepared from this deposit there is a perfect circular valve which can only be compared with *Coscinodiscus minor*, which is, however, a fresh-water species. The question again arises, How came the marine species in the deposit?

Passing to the stratum immediately above the firm mud, which was purely vegetable, I have no hesitation in stating that the curiously serrated forms upon the slides which I have prepared are the siliceous cuticles of the Dutch rush (*Equisetum hyemale*), and probably those belonging to the *Avena fatua*, or wild oat, according to type slides which I have procured for comparison. The deposit has been treated with acid. In many of the slides there are numerous vegetable spores, which I am not able to identify as spores from the *Equisetum*. In the upper portion of the bank, the light greenish tinged deposit appeared, under the microscope, as before stated, to be composed of cylindrical and hollow organisms. After treating this with nitric acid in a boiling condition, the residue was found to contain a considerable quantity of diatoms, nearly all of them easily identified as the very abundant fresh-water species known as *Synedra*. The triangular-shaped ends of the *S. capitata* are very pretty objects, and those frustules which are devoid of the broadened extremities may, no doubt, belong to the *S. splendens*. In the morass there must have been numerous other forms of life which have left no "prints upon the sands of time," but there remains yet another object—the active little *Cypris*, of the Entomostracan group, which led its merry life as usual, at some time or another, during the passing centuries.

Mr. Bartrum said the paper opened up many curious researches as to the physical condition of the early history of the site, and he especially dwelt upon the theory of the influx of the tides. He could not think that the tide had ever reached the bath, notwithstanding the presence of the Hydrobia molluscs, and it would afford a matter for future research, as to whether these creatures are really confined to brackish water.

Major Davis, F.S.A., gave an interesting description of his researches upon the bank of mud and vegetable deposits which had formed the subject of the paper. He also referred to the finding of a Teal's egg in the decayed rushes, with the feathers from that bird surrounding it, and the yelk of the egg, proved to be (after its shell had been broken) in a somewhat petrified condition. He thought it impossible that the tide had ever reached the city since the Roman occupation, as he was able to prove that the present level of the site of the ancient baths was even lower than in its Roman history. He suggested that it might be possible for the shells to have been washed down from the neighbouring hills to the site they at present occupy.

EXPLANATION OF PLATE XXXII.

Section of Mud-Bank at the (Ancient) Roman Baths:

1.—Foundation of the Poor Law Offices.

2.—Faggots used as Fascines.

3.—Upper Deposit.

4.—Middle Deposit of Rushes, Grasses, Equiseta, &c.

5.—Five-foot Deposit of Firm Mud, containing a few Diatoms and thousands of recent Fresh-Water Molluscs.

6.—Roman Tiles, probably the Roof of the Ancient Baths.

The Roman Baths at Bath.

By Major C. E. Davis, F.S.A., Hon. Sec. Soc. Ant., London.

THE following is a short account of the discovery lately made by me of the Ancient Baths and other remains in the city of Bath: these form the most remarkable relics that have hitherto been discovered, of the occupation of Britain by the Romans.

In 1878, the Corporation decided to purchase what was known as the Kingston Hot Springs, etc. In making the excavations necessary to reach, if possible, the actual source of the Springs themselves, there was uncovered a work of surprising grandeur—the Roman enclosure of these hot springs—built to enclose the various sources within that area, and forming an irregular octagonal well, 50 ft. in length; its walls 3 ft. 6 in. high, above the foundations; and when found was for the most part cased within with lead, weighing not less than 30 lbs. to the square foot. A part of this lead has been since sold, and a large portion of it was found to be bruised and broken by the falling-in of the columns and roof; indeed, the whole area of the springs was filled with Roman tiles and masonry, sand, and organic remains, on which rests the mediæval floor of the bath now known as the King's Bath. There were also found two square pedestals of stone marked with Roman numerals, several broken shafts of columns, on one of which was a deposit of iron pyrites, a large quantity of bones, some of them of animals now extinct, as the *Bos primigenius*, nails, and timber.

But the greatest discovery of all, was that of a large Bath, with a portion of its surrounding buildings. This appears to have been connected on the north-west with the octagonal well just mentioned, by a channel or culvert, which conveyed the mineral water into the Bath. The entire enclosure belonging to this Great Bath, and forming its hall, is 111 ft. long by 68 ft. wide. It lies east and west. There are three recesses, or *exedræ*, on the north and south sides, the outer two of which were semi-circular, and the centre recess rectangular. In these recesses were seats, and the clothes of the bathers appear to have been hung up there, as the marks of the rails fixed in the masonry still remain.

A platform, 12 ft. wide, ran round the Bath, and six steps of massive masonry led down to the Bath, the bottom of which was coated with thick lead, in some parts of the same weight as that found in the octagon.

On each of the longer sides of the Bath, and resting upon the upper step, were six clusters of pilasters, thus dividing the entire enclosure into three aisles; the centre aisle, that over the bath and between the pillars, being the highest, and roofed by a barrel vault rising 46 ft. from the floor of the Bath. The side aisles were arched also, but of lesser height, having what is ecclesiastically known as clerestory windows on each side. These arches, except where it was necessary to build them otherwise, appear to have been constructed of hard-burnt hollow tiles, open at the sides, and wedge-shaped, set in the usual Roman mortar, a mixture of pounded brick and lime. The soffit, or under-side of these arches, is coated with mortar having every appearance of being formed of coal-ashes. If this was the composition of the mortar, then the Romans must have been acquainted with our coal-deposits. There was also discovered a leaden pipe, used to convey fresh spring drinking-water to the Bath, which appears to have been conducted through a small recumbent figure in the centre of the north side into a stone cistern, which stood upon a plinth close to the water.

The approach to the Great Bath was by two large doorways in the west, and there were probably three entrances at the other end from the eastern wing, as seems to be indicated by the greater wearing of the pavement in that spot. The remains of the piers are not more than 5 ft. in height from the platform.

The deposits filling the Octagonal well and the Great Bath were very dissimilar. The well was filled with tiles, fragments of trees (one tree with its roots still adhering to the side-wall), alder-sticks, and a great quantity of moss and fibrous matter, supposed to be either straw or rushes. This deposit was in no part stratified horizontally, but in part vertically. Few, if any, shells were found there.

The Great Bath, on the contrary, was filled with a regularly stratified deposit, the lowermost strata of which followed the shape of the platform, steps, and floor of the Bath. This was largely intermixed with fresh-water shells. An account of this deposit forms the subject of another paper in the current number of this Journal.

It is very probable that these remains form only a small portion of a very extensive range of buildings connected with the Roman Baths, and which have been unfortunately covered by parts of the present city of Bath.

Recent Researches on the Bacteria.

By J. B. Jeaffreson, M.R.C.S., Lon., F.S.A., etc.

IF we take a drop of any putrefying liquid and examine it under the microscope, with a power of three or four hundred diameters, a wonderful spectacle meets our view: we find it full of myriads of very minute bodies; globular, oblong, or cylindrical, moving about like a swarm of gnats, twisting in and out of each other, then remaining quiet for an instant and again resuming their active movement. These minute organisms are Bacteria, the subjects we have under consideration in the present paper. Their number is legion, and their presence ubiquitous. They are found wherever albuminoid matter affords the material for sustaining life: in water, in blood, in animal juices and secretions of all kinds, wherever organic matter is passing into decay, there they are present. Associated as they are with the questions of spontaneous generation, putrefaction, and the pathology and therapeutics of many of the most virulent diseases, the investigation of their history cannot fail to be of extreme interest and importance to the general student, the biologist, and the physician.

One great difficulty which meets us in the study of the *Bacteria*, or perhaps I should rather say, in the study of the observations of others on this subject, is the vast differences of opinion which we find existing among different observers. Professor A. says one thing, Professor B. exactly the opposite. C. gives a full, true, and particular account of what D. immediately contradicts. One chief cause of these differences of opinion is the extremely minute size of the organisms under consideration, rendering the use of very high microscopic powers necessary, and requiring therefore extreme and unusual skill in microscopic manipulation, and causing numberless difficulties in their examination, and almost infinite sources of error, which can only be overcome by the highest masters of precise experiment. And as we often have no opportunity of forming an opinion of the skill of the observers, it is frequently difficult to arrive at any definite conclusion, not knowing whom to believe. But when we find that experiments are well and carefully devised, and described with precision (by such men as Pasteur and Tyndall) we cannot fail to attach great weight to their conclusions. So when well-known and accomplished microscopists, (as Cohn, Koch, Dallinger, etc.,) give us the results of their observations, we cannot doubt the reliability of their assertions.

With reference to the difficulty of microscopical investigation, Cohn remarks that "so long as the makers of microscopes do not place at our disposal much higher powers, we shall find ourselves, as regards the domain of the *Bacteria*, in the situation of a traveller who wanders in an unknown country at the hour of twilight, at the moment when the light of day no longer suffices to enable him clearly to distinguish objects, and when he is conscious that, notwithstanding all his precautions, he is liable to lose his way." My object in the present paper will be to try and sift out, and lay before our readers, some of the facts that have been clearly established, and then to see what conclusions may be fairly deduced from them.

The *Bacteria* were known as early as 1675 to Leeuwenhock, who may be called "the father of Microscopy," but for a long time they were looked upon as mere scientific curiosities, and it has only been, of late years, by long and patient research, that their history has been made out, and that they have been relegated to their proper position in the organic world, and it has been known how important a *rôle* they play in the economy of nature. Ehrenberg and the older microscopists supposed that they belonged to the animal world, and classed them with the INFUSORIA, being led away principally by the power of active movement, which they possess in common with the Diatomaceæ, and others of the lower plants, which were also included in the same category. But it is now generally decided (in consequence of the researches of Hoffmann, Cohn, etc.,) that they belong to the vegetable world; and they may be described as minute unicellular FUNGI, either spherical, or more or less filiform, in which case they may be straight, undulating, or twisted into a spiral. Ehrenberg attributed to them a complex structure—stomachs more or less numerous—a proboscis, and cilia serving as organs of locomotion, but more recent observers have failed to find these characters, with the exception of the cilia, which have been verified in numerous instances.

Bacteria may be active or motionless; the same species being sometimes in a state of repose and sometimes of movement. The movement is of two kinds: one a sort of vibration of the corpuscle on itself, and the other a movement of translation from place to place.

Reproduction takes place in two ways, by fission, and by the formation of spores. Multiplication by fission consists in a transverse division of the cell, and the ultimate separation of the two portions. When growth is rapid, the new cells form more quickly than they separate, and are arranged in strings of two to four cells coupled together. According to Cohn's calculation, a single *Bacterium* will produce, in twenty-four hours, as many as sixteen and a half millions, and at the end of a week it will have reached a number which will require fifty-two figures to represent it. This was the only mode of reproduction which was admitted by the earliest microscopists; but Pasteur, Cohn, Koch, and the more recent observers have, by cultivating their filaments in suitable media, distinctly traced the formation of spores in various *Bacteria*.

It is a fact of great importance in the physiology of the *Bacteria* that, in certain stages of their lives, they are able to resist great extremes of temperature without losing their vitality. Moderate temperatures, that is to say, from 77° to 104° Fahr., are generally favourable to their development, the most favourable being about

95°. But while the adult individuals are killed by a temperature of 120° to 176°, according to their species, the permanent spores have been subjected by Schwann, Pasteur, and Tyndall, to from 212° to 230° without losing their power of germinating. Severe cold does not destroy the vitality of *Bacteria:* Cohn having ascertained that they have recovered after an exposure of several hours to a temperature averaging 8° below zero F. But they are benumbed at a temperature of 32° F., losing their power of reproduction and consequently their action as ferments.

As before mentioned it is now decided by all the leading botanists that the *Bacteria* belong to the lowest group of the protophytic Fungi—the peculiar characteristic of which organisms is, that, while most plants feed on *inorganic* or *mineral* substances, and most animals, on the other hand, on the more complex combinations of the organic world, these organisms live and thrive best on organic matters that are passing down, by decay, into the simpler condition of mineral gases. Hence they are sometimes called *Saprophytes* (from σαπρός putrid, and φυτόν, a plant.)

They form the order SCHIZOMYCETES—or Splitting Fungi: and although, in the present state of our knowledge, it is impossible to arrange an accurate classification on a scientific basis, there are five well-marked types into which they may be divided:—The **Micrococci**, the **Bacteria**, proper, the **Bacilli**, the **Vibrones**, and the **Spirilla**.

I.—The **Micrococci** are minute oval or rounded granules, so small as to be immeasurable—but varying from 1-25,000th to 1-50,000th of an inch in diameter. They are motionless, and either solitary or forming small groups or beads; and it is probable that some, if not all, the *Micrococci* are spores of other *Bacteria;* but as some of them have not yet been known to develop under cultivation, they must for the present be classed as distinct.

II.—**Bacteria** are minute, oblong, cylindrical rods, having spontaneous movements: sometimes single, but usually attached in pairs, end to end, the pairs being produced by the self-division of solitary cells, they vary in length from 1-12,000th to 1-5,000th of an inch, and are found to possess flagella; of which, in the paired state, each has one at its free extremity, while the solitary ones have a flagellum at each end.

III.—**Bacilli** are slender filaments, straight, sometimes of considerable length, varying from 1-6,000th to 1-2,500th of an inch in length, endowed or not with motion; and, under cultivation, forming spores, which lie in rows within the rods, and which at length fall to pieces, liberating the germs.

IV.—**Vibriones** are slender filaments, always undulating, distinguished from *Bacteria* by their wavy, serpentine movements.

V.—**Spirilla.** The largest of all the *Bacteria*, (from 1-1,500th to 1-2,000th of an inch long) are characterised by the spiral coiling of the cell, and by their cork-screw-like movement.

Such being a slight sketch of the morphology of the *Bacteria*, we now come to consider what is the part played by them in the processes of putrefaction and of disease.

Putrefaction, as we know, is the tendency of all dead organic matter, under certain conditions, to undergo various processes of disintegration, evolving offensive gases, and giving rise to various new chemical combinations. Intimately connected with this process is found to occur the growth and multiplication of living organisms. The point we have first to consider is—How they come there. This question has been for many years the battle-field of the various theories of the Origin of life. Here the biologists are ranged into two opposing factions. On the one side are placed those, who, carrying the doctrine of Evolution to its fullest extent, suppose that the unbroken chain of continuity which runs through the whole organic world—plant and animal gliding imperceptibly into each other—is also carried downwards into the inorganic—the living gradually gliding into the non-living—until all Nature is one grand sequence and continuous whole. The link between the organic and the inorganic being the *Bacteria*; and the mode of their development being that they are the result of the normal re-action of the air, under certain circumstances, upon the non-living elements with which it is in relation. The process being analagous to the phenomenon of crystallisation; as in the formation of crystals, certain molecules, under certain conditions, assume definite geometrical forms, so certain other molecules under certain other conditions, assume the appearance and attributes of vitality.

On the other side are those biologists who say that though there *may have been* this line of continuity, we cannot say that it exists at the present time; that spontaneous generation is no *discovered* part of Nature's processes; but that "the properties of living matter distinguish it absolutely from all other kinds of things," and that the facts to-day in the hands of the biologist "furnish us with no link between the living and the non-living." They say that as the whole analogy of Nature supports the aphorism of Harvey—*Omne vivum e vivo*—that as every existing living animal, as far as we know, is evolved from a pre-existing animal of the same species, and as every plant is developed from a pre-existing similar plant, so with the *Bacteria*, we have every reason to suppose that they are always developed from pre-existing individuals of the same organisms.

The proofs relied upon by the advocates of the former theory are chiefly the following:—It is argued that as the adult *Bacteria* are killed at a given temperature—much below the boiling point of water—if an infusion is boiled with every possible precaution, and while boiling hermetically sealed, and if, after a lapse of time, the vessel is opened, and found to contain living organisms, they must have arisen *de novo;* that is, the non-living have produced the living.

The opponents of this theory, on the contrary, say, that the difficulties and possible errors in such experiments are unbounded; that while the adult *Bacteria* are destroyed by a moderate temperature (say 140° F.) the spores can bear a much greater amount of heat,(even exposure to as high a temperature as 260° F., or possibly more than this), without losing their vitality; and that if an organic infusion is subjected to a sufficient amount of heat, with due precautions to prevent any possible source of error, it may be absolutely sterilised: and if then hermetically sealed, as long as no air is admitted, or only air deprived of its organic particles, no life is ever developed.

It is to Tyndall that we are indebted for a series of beautiful experiments in support of the foregoing conclusions. We all know the effect of a beam of sun-light or other concentrated ray passing through the air, how it reveals to us the numerous dancing motes which are invisible in ordinary light, and are even so exquisitely minute as to be beyond our highest microscopical powers. While experimenting on the decomposition of vapours by light, Tyndall was under the necessity of obtaining air that was absolutely free from any impurity. He found that if the air was passed over the tip of the flame of a spirit-lamp, the floating matter no longer appeared, having been burnt up by the flame; it was therefore of *organic* origin. By further experiments he discovered that this organic matter could be removed by filtering the air through cotton-wool, calcining it by passing it through a platinum tube containing a roll of platinum gauze heated to vivid redness, or allowing it to deposit its impurities by subsidence in a closed chamber: the proof of its purity being, that the electric beam in passing through it, leaves no trace of its path. When air thus purified was admitted to a sterilised infusion no development of life took place; but if, on the other hand, ordinary atmospheric air was admitted, in a few days the infusion was found to be swarming with living organisms; the deduction being that these organisms were developed from the minute particles of organic dust which are always floating in the air, which particles are actually spores; and these, on obtaining admission to the putrescible infusions, gave rise to the *Bacteria*.

The advocates of Spontaneous Generation declare that there is absolutely no evidence whatever of these invisible spores; but Pasteur first, and after him several other observers, claim to have demonstrated their existence microscopically. By causing a current of air to pass for some time through a glass tube, in which a pledget of gun-cotton is placed, the germs and other particles of atmospheric dust are intercepted, and if the gun-cotton is then dissolved in ether, and the sediment examined with the microscope, a certain number of germs are always visible.

It is, however, quite within the bounds of possibility, that the germs of many of the *Bacteria* may be invisible, even to our highest microscopic powers, until they have commenced to grow, and are somewhat developed beyond their original size. Some of the beautiful observations of Messrs. Dallinger and Drysdale throw light upon this suggestion. In watching some of the larger Monads, a process of conjugation was seen to take place between two individuals, after which a delicate glossy sac opened gently at one place, and from it streamed out a glairy fluid densely packed with *granules*, which were just visible when the area was increased six million times; a group of these granules was watched under the microscope without intermission, and they were gradually seen to develop, until at the end of six hours they had assumed all the characters of adult specimens, and proceeded to complete their life-cycle by reproducing themselves by the act of self-division. Among the most minute Monads which were observed, a similar act of conjugation was seen to take place, followed by the emission of a similar glairy fluid, but here, at first, no power could detect a single *granule*, but on continuously examining with a lens magnifying 5,000 diameters, the spot where the fluid had rolled, within one hundred minutes a number of the minutest conceivable specks came into view (compared by Dallinger to the growth of the stars, in an apparently starless space, upon the eye of an intense watcher in a summer twilight), and these, as in the former case, were carefully watched until they were seen, in the same manner, to develop themselves into the parent condition. Now if the germs of these Monads, the adults of which are three times as large as the *Bacterium termo*, are proved in their earliest stage to be invisible to our highest microscopic powers until they have undergone a certain amount of development, surely it is not incredible that Bacterial germs are for a time equally beyond our powers of vision.

The balance of evidence certainly appears to me very much in favour of the Atmospheric Germ Theory; and the conclusion to be drawn is that the *Bacteria*, in any putrefying infusion, spring, not from any spontaneous combination, but that they are developed from germs which are everywhere floating in the atmosphere, and which have thus obtained admission to the putrescible substance.

I cannot do better, as a summary of the conclusions arrived at, than give you the words of Tyndall himself:—"From the beginning to the end of the enquiry there is not a shadow of evidence in favour of the theory of Spontaneous Generation. There is, on the contrary, overwhelming evidence against it; but do not carry away with you the notion, sometimes erroneously ascribed to me, that I deem Spontaneous Generation *impossible*, or that I wish to limit the power of matter in relation to life. My views on this subject ought to be well known. But possibility is one thing, and proof is another; and when in our day I seek for experimental evidence of the transformation of the non-living into the living, I am led inexorably to the conclusion that no such evidence exists, and that in the lowest, as in the highest of organised creatures, the method of Nature is, that life shall be the issue of antecedent life." *

As to the actual part played by the *Bacteria* in putrefaction, we again find ourselves on debateable ground. We may take it for granted that no decomposition takes place without their being present; the disputed point is whether their connection with the process is only accidental, or whether they are the actual cause of the phenomenon. The Heterologists, or advocates of Spontaneous Generation, say that the molecules of a putrefying body are in a state of motion tending to the disruption of their elements, and that the *Bacteria* are not the cause of this so-called *motor-decay*, but that they are the result of the contact of non-living elements in this condition, with the physical forces of the atmosphere in relation with them. Their opponents (on the contrary) say that the organic elements of a putrescible compound undergo disruption by no inherent tendency of their own, but that putrefaction is directly occasioned by the influence upon them of these living, growing, and multiplying organisms; whether they generate a ferment which produces this effect, or whether they do so by their very acts of life and growth.

Perhaps, in the present state of our knowledge, it is better not to attempt too precise a definition on the subject. There is, however, no doubt that, in the absence of *Bacteria*, putrefaction is a very slow process, and we may therefore conclude that, even if they do not originate the process, they immensely hasten it: so that it is owing to these infinitely minute agents that the transformation of dead organic matter, into matter suitable to take its place in the general current of natural processes, is hastened and completed, and an equilibrium maintained between the organic and the inorganic world: and it is not too much to say that it is

* Tyndall's Paper at the Royal Institution, June 8, 1877.

owing also to their action that the continuation of life is possible on the globe.

We now come to consider what is, practically, the most important part of our subject, namely, the connection of the *Bacteria* with disease.

Some years ago it was the current belief that epidemic diseases generally, were propagated by a kind of malaria, which consisted of organic matter in a state of what was known as *motor-decay;* and that when such matter was taken into the body, through the lungs, skin, or stomach, it had the power of spreading there the destroying process which had attacked itself; much as fermentation is produced by the presence of yeast. But when in 1837, Schwann and Cagniard de la Tour discovered the yeast plant, and subsequent observers discovered the connection between putrefaction and the *Bacteria*, the idea was gradually evolved that these organisms might also be concerned in the propagation of the contagious or zymotic diseases.

To no one are we more indebted for our knowledge in this field of medical study than to Pasteur, not only through his own immediate experiments, but also for the new direction he has given to scientific discovery, the new clues, and new paths of research which he has opened out. Closely following Pasteur in careful and original research comes Koch, who when only a young physician in a small country town in the neighbourhood of Breslau, made a world-wide reputation by his masterly investigations, causing him to be transferred to the post of Government-adviser to the Imperial Health Department of Berlin. Many other observers are also doing good and careful work, striving to detect the presence of *Bacteria* in different diseases; and, when found, working out their life-history, and daily adding to our knowledge of the subject.

The microscope is, of course, our main aid in the study; and considering the extreme minuteness of the *Bacteria*, it is only by the use of the most perfect instruments that we can expect to learn anything about them; and none but highly trained microscopists are likely to deduce accurate results from their observations. Not only on account of their minuteness, but also because they frequently have the same refractive index as the fluid which contains them, the *Bacteria* may escape observation. To remedy this, various processes of staining have been introduced, for the first suggestion of which we are indebted to Koch. Fortunately all *Bacteria* and *Micrococci* have great affinity for aniline colours, and are strongly stained by them. We may easily try this for ourselves. If we take the slightest smear of mucus from the mouth, nose, or any of the openings of the body, and dry it on a slide, we shall not be able to detect anything; but if we place upon it a drop of aniline violet ink, allow it to remain a minute or two, and then wash it off with a gentle stream of water, we shall find plenty of material for study.

When the *Bacteria* are contained in animal tissues, somewhat more complicated processes are necessary. The staining of the whole substance sometimes obscures our view of the *Bacteria*, but owing to their superior affinity for the aniline colours, it is found possible, by suitable chemical re-agents, to discharge the colour from the surrounding medium, which may then either be left colourless, or subsequently stained with some other colouring matter, to throw into more vivid contrast the unaffected *Bacteria*. The way in which different *Bacteria* are acted upon by different colouring matters and chemical re-agents, seems likely to be of use as a means of diagnosis between varieties.

Having discovered the existence of *Bacteria* in a diseased animal, by the microscope, the next process is to cultivate them outside the body of the animal in which they are found, so as to have an opportunity of watching their life-history; and having obtained them perfectly pure, and free from contamination with any of the fluids of the body, to make further experiments as to their effects when introduced by inoculation into the bodies of healthy animals. Cultivation may be carried on either in chemical solutions or in animal broths, which are sterilised by suitable elevations of temperature, in tubes plugged with cotton wool to prevent the accidental introduction of atmospheric germs. Such sterilised fluids are charged with the minutest drop of fluid known to contain the *Bacteria*, which soon multiply to an enormous extent, and from which any number of successive inoculations may then be made in fresh portions of fluid with the same result.

In studying the life-history of the *Bacteria*, by means of cultivation, it is sometimes found difficult to prevent various species growing together, so as to mask each other, and to render it impossible to determine what effects are due to each species. Lister, in order to overcome this difficulty, proposed to introduce a drop of an infusion, which might probably contain twenty species, into a large quantity of water, the dilution being calculated so that a *single* drop of the diluted Bacterial mixture would probably contain a single *Bacterium;* which drop, when removed to a tube of sterilised fluid nutriment, would only produce a progeny of that particular *Bacterium.* But Koch has devised a still more ingenious plan. He spreads a layer of gelatine, so saturated with water as to become solid on cooling, on a glass slide. It is sterilised by boiling, and into it can be introduced some nutrient matter required by the *Bacteria.* In order to obtain pure cultivations a sterilised needle is dipped into a mixture containing various species, and with it a streak is made down the gelatine fluid. *Bacteria* are dropped at intervals; when, owing to the medium being solid, no mixture occurs; but each *Bacterium* produces round it a spherical nest of its own kind, from which individuals can be removed (with a sterilised needle) to start fresh, pure cultivations; by which means alone their specific characters and distinctive properties can be studied.

We now come to some of the special series of observations which have been carried out upon the *Bacteria* found to be associated with various specific diseases. The first epidemic which was thoroughly investigated was a parasitic disease of silk-worms—called *Pébrine*—which, in 1865, was brought under the notice of Pasteur. This disease, which for fifteen years had devastated the silk-producing districts of France, was proved by him to be caused by a multitude of minute corpuscles—the *Micrococcus Bombycis*—which bred in the worm, and so caused its death.

In 1850, Messrs. Rayer and Davaine found that the blood of animals affected by Splenic Fever, Anthrax, or Charbon, contained minute transparent rods; and since then the history of these organisms has been beautifully worked out by Koch. He cultivated these *Bacilli* in the aqueous humour of the eye of an ox, or in other suitable organic fluids, kept at a temperature of nearly blood-heat. At first the rods appear to be simple tubes, divided by transverse partitions, but after a time minute dots are seen, which develop into ovoid bodies, lying in rows within the tubes; until at last the rod falls to pieces, liberating the germs, and the minutest drop of fluid containing the spores starts the process of growth and reproduction in other organic fluid, or developes the disease in the bodies of healthy animals inoculated with it; and this may be repeated many times without impairing its potency. Koch also showed that the blood may even be dried, kept for years, and reduced to powder, without losing its power.

Pasteur next examined outbreaks of Charbon among sheep. For a long time he was unable to account for the appearance of the disease among flocks apparently free from any chance of contagion; but he ultimately found that it was customary to bury the dead bodies deep in the soil. It might be as many as ten or twelve years before a fresh outbreak, and he divined that earth-worms might possibly be the cause of communicating the disease, and on inoculating rabbits and guinea-pigs with an extract of the alimentary canal of these worms, he found that they were attacked with the severest form of Charbon, and their blood was found to be loaded with the deadly *Bacillus Anthracis.*

Among other experiments on Anthrax, Pasteur found that birds were insusceptible of the disease; knowing that the temperature of the mammalia (about 99° F.) was most favourable to the development of the *Bacillus*, but that the temperature of birds was higher (namely, 107° F.), he supposed that this might be the reason of their insusceptibility, and it struck him that if he could reduce the temperature of birds to that of mammals, he might be able to inoculate them with the disease; this he succeeded in doing by keeping their feet in cold water, when he found that they could be made to take the disease. Frogs, on the other hand, whose temperature is lower than that of mammals, could be made susceptible by keeping them in water at about 99° F.

Further researches on Anthrax have been made by Dr. Greenfield in our own country, while similar experiments have been made by Klein on the typhoid fever of swine, which he finds depends on the *Bacillus minimus*. Klebs and Tomassi Crudeli have shown the connection between certain filamentous *Bacteria* and Intermittent Fever; and M. Richard says that he detects malarial *Bacteria* in the red blood-cells, where they grow and undergo development. But here, again, the doctors differ. Dr. G. N. Sternberg, of the United States, who has been investigating the subject, does not consider the evidence sufficient, and though he does not say that the *Bacillus Malariæ* is *not* the cause of malarial fever, he suggests that the *experimentum crucis* should be made on man himself, isolating and cultivating the various organisms, and investigating their action when taken into the stomach, or respired in a dry state by healthy individuals—an experiment to which, if a willing subject could be found, even our own anti-vivisectionists might not object. Some observations made during a famine which occurred at Breslau, in 1872, showed that a species of *Spirillum* bears a definite relation to epidemic visitations of famine-fever, the cork-screw-like threads being invariably found in the blood; and in India the specific nature of the disease has been proved by the inoculation of quadrumana with infected blood.

This brings us to Koch's recent and brilliant discovery of the *Bacillus Tuberculosis*. It was suggested more than thirty years ago, by Dr. Budd of Bristol, that *tubercle*, which constitutes the essence of such diseases as Consumption and Scrofula, was analagous to the eruptive fevers in everything but the slowness of its progress. Since his time other observers have shown that it can be inoculated in the lower animals from the human subject; while others again have proved that similar infection can be caused by allowing animals to breathe air charged with tuberculous matter. In the meantime the belief arose that the common eruptive fevers were caused by *Bacteria;* and now it has been shown, by Koch, that they are also always found in connection with tubercle.

Koch's first method of preparing the tuberculous matter to exhibit the *Bacteria* was the following:—It is kept in contact for about twenty-four hours with a half-per-cent. solution of methylin blue; a small quantity of a ten-per-cent. solution of caustic potash is then added; and after this it is stained for a minute or two, with a concentrated solution of vesuvin, and then washed with distilled water. The cells, nuclei, fibres, and granules now appear of a brownish colour, while the tubercle *Bacilli* stand out in a beautiful blue tint. All other *Bacteria* and *Micrococci* known to Koch, except those of tubercle and leprosy, lose their blue by this process.

More recently Koch's assistant, Dr. Erlich, has introduced a new process. He first stains the tuberculous matter with magenta, and then applies dilute nitric acid, which removes the colour from everything but the *Bacilli:* and Dr. Heneage Gibbs has still further improved upon this plan, by first staining with magenta, then removing the colour from the surrounding matter by dilute nitric acid, and afterwards adding a solution of Chrysoidin, which stains the groundwork brown, leaving the *Bacilli* a reddish violet.

Very recently a method has been suggested for the detection of the *Bacilli*, in the breath of consumptive patients. A respirator is provided containing two layers of gun-cotton, and the patient is ordered to breathe frequently during the day through this. The external layer will intercept the suspended particles in the in-going air, while the internal layer retains only the particles coming from the lungs; after being used for some time the internal layer is dissolved in a mixture of rectified spirit and ether, and the solution thus obtained is spread in the thinnest possible layer on a glass slide. It is then stained by one of the processes before mentioned, when the *Bacilli*, if present, are rendered visible. And still more recently, by a similar process, the *Bacilli* have been detected in the air of the Consumptive Hospital at Victoria Park.

To cultivate the *Bacilli*, pure serum of the blood of sheep or cattle is sterilised by keeping it for six days in test-tubes, plugged with cotton-wool, and exposed daily for one hour, to a temperature of 136° F. After this it is heated for several hours at a temperature of 150° F., by which it is changed into a solid transparent mass. It is then inoculated with any tuberculous matter, and kept at a temperature of about 100° F., for one week, when it becomes gradually covered with colonies of tubercle *Bacilli*. These *Bacilli* are very small rods, in length about one-third that of a blood corpuscle, in breadth about one-sixth of their length. From a minute portion of this culture other inoculations are formed, often for many generations, and the *Bacilli* thus produced are found quite effective in invariably causing the reproduction of the organism, and the generation of the original disease when introduced into the bodies of healthy animals.

Special organisms have recently been found connected with glanders. Many other observers have at various times reported the discovery of certain specific *Bacteria* which they have regarded as the pathogenic element in the production of certain specific diseases. This, however, can only be proved by demonstrating that the organisms, when cultivated outside the animal body, are capable of giving rise to such maladies; and in many of these observations, the deductions are so covered by inexact assertions and improbable hypotheses, that it is impossible to draw any definite conclusions from the observations.

The next step in the study of Bacterial pathology was the discovery, by Pasteur, of the possibility of modifying (by cultivation) the potency of the *Bacteria* as agents of disease. This discovery was made during investigations as to a disease of fowls, called Chicken Cholera. This is a disease of extreme virulence, proving rapidly fatal, and capable of being constantly induced by inoculation of the smallest drop of the blood of a diseased fowl under the skin of a healthy one, one attack, if recovered from, being a permanent protection from subsequent attacks. It is proved to be caused by a microscopic parasite which can be cultivated outside the animal.

If we take a fowl that has just died of Chicken Cholera, dip the point of a glass rod into the blood, and touch with the charged point a decoction of fowl broth which has been sterilised by being heated up to about 240° F.; keeping the liquid at a temperature of 77° to 78° F., and taking care (as in Tyndall's experiments) to prevent the entrance of atmospheric germs, in a short time, it becomes turbid, and is seen under the microscope to be crowded with minute *Bacteria*, shaped like the figure 8. If from this vessel we take the smallest drop, and charge a second quantity of the sterilised fowl-decoction, the same phenomenon is produced; and the same process may be repeated an unlimited number of times with the same result. After two or three days the thickness of the liquid disappears, and a sediment forms at the bottom; this denotes that the development of the *Bacteria* has ceased, and things will remain in this condition for a longer or shorter time, even for months, without any visible alteration, provided atmospheric germs are excluded by a plug of cotton-wool. If we now take one of these cultures—say the hundredth or the thousandth for instance—and with a drop of it inoculate a certain number of fowls, it will be found that it is just as fatal as if they were inoculated with a drop of blood taken directly from a fowl that had died of the disease. They will all die equally quickly, and with the same symptoms, and their blood after death will be found to contain the same minute organisms. But if, instead of repeating our cultures at periods of only a few days, we make them at intervals of one, two, four, six, or even ten months, we shall find that the virulence of the successive cultures is greatly altered; and that, if we now repeat our experiments of inoculating healthy fowls with our cultivated fluids, we shall discover that one preparation will be fatal to eight out of ten, another to five out of ten, and another to none at all, although the *Bacteria* may still be cultivated, and the ten will all suffer from a modified attack of the disease. Finally, if we take these attenuated cultures, and without any interval, start from them fresh cultivations, we shall find that each of these new cultivations will retain the same amount of virulence as the one from which it was started. This brings us to what is practically the most important point of these investigations, namely, that when the fowls have been made sufficiently ill by the attenuated virus, they may afterwards be inoculated with the most virulent, and will suffer no evil effects, or only effects of a passing character.

The question naturally suggests itself: what is the cause of this diminution of the virulence? Pasteur's answer to this inquiry is that it depends on the effect of the oxygen of the air. If we carry on our culture in a tube containing very little air, and then hermetically seal it, we find that the development of the virus continues until all the oxygen is exhausted; the cloud then falls, the virus is deposited on the sides of the tube, and on opening the tube at the expiration of from one to ten months, we find the virulence always identical with the virulence of the original culture used in the preparation of the tubes; while if some of the tubes prepared at the same time, and from the same culture, are kept exposed to the air, we find the virulence either extinct or very feeble.

Pasteur, Koch, and Greenfield, following out this line of discovery, found that similar attenuation could be made of the virus of Anthrax, so that with equal certainty, animals which had suffered from a mild attack produced by the attenuated virus, could be inoculated with virus from the most severe forms without fear of an attack. Modification has also been found to take place when the virus has repeatedly passed through animals of another type; thus, Dr. Greenfield has proved that the poison of Anthrax can be attenuated, and a protective virus be procured by repeated passage of the bovine poison through the bodies of rodents.

Not only medical, but also surgical science has been promoted by the application of the Germ Theory. The idea suggested itself to Lister that the reason why certain surgical injuries and operations were followed by pyemia, erysipelas, and the production of putrefying pus, was that they became infected by bacterial germs floating in the air, and that if we could exclude these germs, one of the greatest scourges of surgery would be removed. In order to do this, every precaution is taken during an operation to prevent the admission of germs to the wounded surface, and to take care that, if they do come in contact with it, they are immediately killed by being exposed to a spray of diluted Carbolic Acid; the wound afterwards being most carefully protected by antiseptic bandages. The results produced by this mode of treatment, or at all events by some modifications of it, have been most satisfactory.

In summing up the conclusions we may arrive at, it will be well to note that the actual value of new discoveries cannot be appraised at once. Sometimes the discovery is undervalued, more frequently it is over-estimated. Of no advance in Medical Science is this more true than in the discoveries of Bacterial Pathology. Though the remarkable fact of the relation of living organisms to disease, which has been ascertained by the investigations of late years, has been profoundly important, we must feel that at present the study is in its infancy, and we should be careful not to be led away by the interest of the observations, to jump at conclusions which are not justified by the facts at our disposal, and to regard the *Bacteria* as all and everything in the pathology of diseases.

We may take it as proved, that many diseases are definitely connected with the presence and development of certain *Bacteria*; and where, as in the case of Anthrax and Chicken Cholera, these organisms can be cultivated outside the animal body, and on being inoculated in a healthy subject, are found to give rise to the malady, there can be no doubt that they constitute the actual cause of the disease.

Besides these, it *is probable* that many other diseases, as cholera, measles, scarlet-fever, typhoid, diphtheria, and others of a zymotic character, are all caused by SCHYZOMYCETOUS FUNGI; but no complete or exhaustive observations are as yet published concerning them. The analogy of their symptoms with those of the known bacterial diseases affords a strong presumption in favour of the theory. Their contagious nature is most naturally accounted for on the supposition that the poison germs of the disease, when passing from the body of the sufferer, impregnate the atmosphere around him, so that anyone in that atmosphere must necessarily breathe these germs, which enter through the delicate walls of the capillaries of the air-cells into the circulation, where they live, grow, and reproduce others like themselves. The premonitory stage of incubation corresponds with the time taken by the development of the *Bacteria* in the system after infection, the febrile state with their full development, and the period of convalescence with the gradual decline of the *Bacteria*, when the nutritive elements on which they exist are exhausted; while the freedom from liability to a subsequent attack also holds good with the analogies of Anthrax and Chicken Cholera.

One of the most important questions at the present time is, What is the practical value of the organisms which seem to be so intimately connected with the formation and growth of tubercle? Many well qualified observers are studying the subject, and we may hope that ere long much important light will be thrown upon it. The discovery, at all events, enables us to understand how consumption *may* be contagious, though at present it does not afford any additional proof that it is so, and on the other hand it has rather increased the difficulty of explaining its hereditary character.

It may no doubt help us in determining whether a suspected case is actually one of consumption or not; as when looked for by practical observers, the *Bacillus* has invariably been found in confirmed cases of Phthisis, whereas in ordinary Bronchitis the search has always been in vain. Dr. G. A. Heron, who has been paying special attention to this subject, considers that the numbers and forms in which the *Bacilli* are found in the expectoration of consumptive patients, is likely to be of great use in forming an opinion as to the probable gravity of the disease. That where, in the early history of a case, they are few in number, it will probably run a long course; but that if, on the contrary, the *Bacilli* are persistently numerous and grouped in considerable masses, it will run a short course, and rapidly end in death.

The power of modification of the potency of Bacteria, as agents of disease, also throws much light upon many of the phenomena of Zymotic diseases. It opens up the possibility of affording protection against all diseases which are caused by *Bacteria*, by attenuating the virulence of such disease germs by successive cultivation, and then by inoculation causing a mild attack of the disease which shall be protective against severe attacks. This, as we have seen, has been practically carried out in the case of Chicken Cholera and Anthrax. The statistics for the department of the Eure-et-Loire in France, for last year, have shown that in inoculated flocks of sheep, the mortality has been reduced to one quarter of what it would formerly have been, while among inoculated cows and oxen it has been reduced from 7·03 to ·24 per cent.

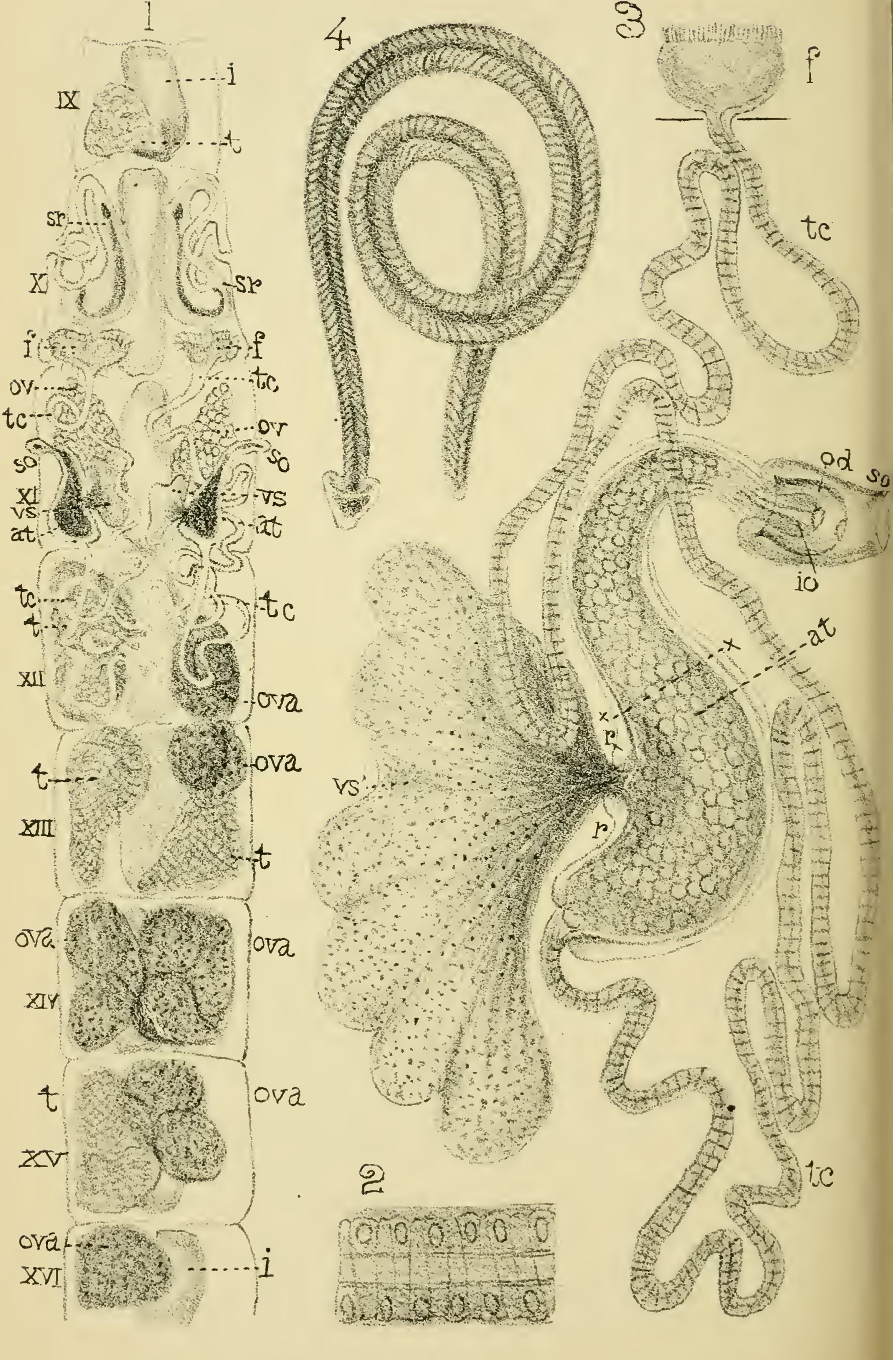
The modification of other organisms by their "environment" may also help us in considering the modifications of the *Bacteria*. We know that many of our most valuable plants and fruits are "cultured" varieties of useless and semi-poisonous vegetables, and we see that many fungi produce transitional form, according to the host on which they are developed. Thus the common wheat mildew (*Puccinia graminis*), if sown on young berberry plants, produces the *Æcidium Berberidis;* while the Æcidium spores sown on young wheat produces the *Uredo*, which is the first stage of Wheat mildew, each form being confined to the special plant on which it is produced. So with the salmon-disease. Dead flies are often seen in the autumn sticking on the window-panes, their bodies covered with fine white powder, and the same substance adhering to the glass beneath and around them. These dead flies have been attacked by a parasitic mould, which never advances beyond a very simple condition on the flies in the air; but should an infected fly fall into the water, a much more elaborate development is given to the mould; and should the fly come in contact with an unhealthy salmon, it may develop into the pathogenic fungus which is the cause of salmon-disease.

Dr. Roberts, of Manchester, has suggested that disease germs may be modifications or "sports" from harmless Saprophytes, which, from alterations in their surroundings, have acquired a parasitic habit, and so become dangerous to life. This idea, and Pasteur's discovery, that the attenuation of the virus depends upon the presence of oxygen, leads to the conclusion that various alterations in the "environment," the deprivation of oxygen, or the cultivation in gaseous mixtures from which the normal supply of free oxygen in air is absent, may have an influence in converting harmless germs present in the atmosphere into the dangerous *Bacilli* of disease; and that we should not so much try to prevent infectious diseases by bringing into vogue new methods of vaccination, but rather combat them by extended sanitation, fighting diseases outside, not inside the body. May it not explain the efficacy of isolation, the utility of oxidising disinfectants, the salubrity of the country, contrasted with the unhealthiness of towns; the success of cool or open-air treatment in certain cases of illness, and the decline of zymotic diseases before the progress of sanitation?

Dr. Angus Smith has further suggested that the putrefying process, when carried on in confined places, as sewers, may cause a development of disease germs which does not take place when the same processes go on in unconfined places. Analogous conditions may exist in the lungs of persons living in vitiated atmospheres, in ill-ventilated rooms, or engaged in sedentary occupations, not taking sufficient exercise, or of feeble respiratory habit. Innoxious germs in the atmosphere may be inhaled and retained in the lungs of such persons, and then by successive culture and deficient aëration acquire a parasitic or deadly character. This may account for the development of typhoid and other fevers, and of consumption in in-sanitary buildings, and also for the benefit obtained by consumptive patients by change of climate, sea-voyages, the air of pine-woods, inhalation of Carbolic Acid, etc. If the *Bacilli* were the sole cause of consumption, as all must be exposed to the risk of contagion, it would seem that no one could possibly escape ; but, as it is only the minority who succumb, it is probable that there must be some prior condition which favours its development,—a state of health or constitution which is a main factor in the production of the disease, and which is as necessary to the growth of the *Bacilli* as is the manuring and preparation of a garden for the crop which is to grow in it.

Not only air but also water may convey poison germs into our system; and the reason why water contaminated with decomposing vegetable matter, or sewage, is so fruitful a source of disease, is, that such water supplies suitable nutriment to all the bacterial germs, which grow and propagate therein, and not only propagate but develop more intensely poisonous characters in such contaminated water; and we thus see how it is that boiling renders such water innocuous by destroying the contained *Bacteria*. Professor Mathieu Williams has thus accounted for the density of the population of China, from the fact that, in spite of the general insanitary condition of the country, the small amount of cleanliness, and the crowded condition of the people, the usual drink consists of *boiled* water, flavoured with an infusion of tea-leaves, which may thus be a great protection against the spread of zymotic disease.

The study of Bacterial disease has also helped us to understand the connection between vaccination and small-pox. Jenner suspected that cow-pox might be small-pox modified by passing through the living cow; since his time, however, the prevailing opinion has been that they are two distinct diseases; but recent observations seem rather to prove that they are modifications of the same poison: that is to say, that Cow-pox (or the disease, produced by vaccination) is actually human small-pox modified by its passage through an animal of the bovine species. The discovery that the poison of Anthrax may be mitigated by passing it through the system of a living rodent, and that on retro-vaccination with this lymph in the body of a living ruminant, it forms a protection against a fresh attack, appears to support this theory. While the facts that cow-pox, as it occurs naturally, is a disease


1
2
3
4
IX
i
t
sr
X
sr
f
f
ov
tc
tc
ov
so
so
XI
vs
vs
at
at
tc
t
tc
XII
ova
ova
t
XIII
t
ova
XIV
ova
t
XV
ova
ova
XVI
i
f
tc
od
so
io
x
at
x
r
vs
r
tc

affecting the udder of the cow, male animals not being affected by it; and that since small-pox has so much decreased in the rural districts, Cow-pox is almost extinct, raises a strong presumption that it was produced by inoculation from the hands of convalescent patients.

I must now bring this long paper to a conclusion. My limits are exhausted, but not my subject. No branch of science has, in the words of Charles Kingsley, "helped so much to sweep away that sensuous idolatry of mere size, which tempts man to admire and respect objects in proportion to the number of feet or inches which they occupy in space"; and the study has shown us how these minute organisms have, perhaps, had more important relations in reference to the existence of life on our globe than the vast denizens of our primeval forests, or even the gigantic Saurians of previous geologic epochs.

On Tubifex Rivulorum.

By A. Hammond. F.L.S.

Second Paper.*

Plates 33 and 34.

THE reproductive system of Tubifex presents many points of interest, enhanced perhaps by their obscurity and the different opinions that have been advanced concerning them. I will give, therefore, a *resumé* of Claparède's observations, adding the views of Lankester, which appear in some cases diametrically opposed thereto, and such remarks of my own as the occasion may seem to warrant.

I may say, in the first place, that these worms are hermaphrodite, uniting both sexes in one individual; but, as generally happens, the congress of two individuals is necessary for the completion of the reproductive cycle. Each worm, therefore,

* For First Paper, see Vol. I. of this Journal, p. 14.

contains both male and female organs. According to Claparède, the male organs consist of the testes and vasa deferentia; the former number at least two, and sometimes three in mature specimens. The first of these is found in the ninth segment (see Fig. 1, Pl. 33, and the second in the eleventh, whence in course of development it invades the proximate segments, sometimes so far as the fifteenth, by pushing before it, in the form of a sac, the septa which divide one segment from another. A third testis is described as being sometimes found in the eleventh or twelfth segments, and lying in a separate sac alongside the second. These three testes have all a very similar appearance, and enclose spermatozoa in all stages of development. When the spermatozoa arrive at maturity, they escape, by the rupture of their containing sac, into the perivisceral cavity, where they may be found abundantly in the tenth and eleventh segments, attached, as he says, to their "spheres of development."

The vas deferens (Fig. 3) is a modified and extraordinarily developed segmental organ, composed of three parts, which he calls respectively the funnel, the ciliary tube, and the atrium. This latter communicates with the intromittent organ. The funnel is found in the septum separating the tenth from the eleventh segments, its cavity opening into the former, and presents the appearance of a cup, the edge of which is fringed with cilia, in which, at the epoch of maturity, the spermatozoa are entangled. With the funnel is connected a long, convoluted ciliary tube, the coils of which occupy the eleventh and sometimes the twelfth segments. It is regularly striated, which appearance is due to the presence of a series of fusiform unicellular fibres, disposed circularly round the ducts in such a manner, that the thick part of one lies next to the thin part of the ring which precedes it, thus allowing a succession of these rings to constitute a cylinder (see Fig. 2). The interior of the duct thus formed is ciliated. The atrium is the lower and dilated portion of the vas deferens, and is described by Claparède as having a thick outer wall, inside which is a delicate membranous one, and inside this again is a ciliated epithelium. It communicates with the intromittent organ.

An organ which, for want of a better name, he calls a seminal vesicle, is further described in connection with the vas deferens. It is a large pouch, grafted to the atrium in a very remarkable manner. Its wall is continuous with the two internal layers of the atrium, but not with the external layer; the latter, therefore, presents a perforation through which the communicating neck between the seminal vesicle and the atrium passes. The edges of this perforation are thickened, and the appearance is thereby produced of a ring encircling the neck of the vesicle, as a graft on a tree is encircled by the bark. The vesicle itself is filled with epithelial cells.

The female organs are enumerated as follows:—An ovary, an oviduct, and a pair of seminal receptacles (see Fig. 1). The ovary is double, and placed in the eleventh segment. Each ovary is pear-shaped, and adheres by its narrow extremity to the posterior surface of the septum separating the tenth from the eleventh segment, and is formed by the agglomeration of a multitude of ovules. The eggs arrive successively at maturity, and having attained twenty or thirty times their original volume, are pressed against the septum eleven—twelve, whence they pass alongside the second testis, and are speedily followed by others. The septal sac in which the testis and eggs thus lie, and which we may regard as a matrix, sometimes extends as far as the seventeenth segment, but it is open in the eleventh, and the mature eggs must thus be considered to float in the perivisceral cavity. The opening by which the eggs arrive at the exterior is difficult to find in *Tubifex*, and Claparède infers, in the absence of direct observation, that the passage taken by them lies between the thick outer wall of the atrium, and the inner membranous one. It will be remembered that the former is described as perforate around the neck of the seminal vesicle, and it is thought that the thickened ring forming this perforation, opens and allows the eggs to pass. The atrium, or lower portion of the vas deferens would, according to this view, be invaginated in the oviduct; the orifices of these two organs are described as situated one within the other in the sexual orifice, which is found in the eleventh segment. Lastly, there is a pair of sac-like seminal receptacles situated and opening externally into the tenth segment, in which Claparède remarks that there is sometimes found an Opalinoid parasite belonging to the genus *Pachydermon*.

Such is Claparède's account of this curious organism, which, if the reader would understand, he must carefully compare with the figures illustrating this article, and with the worms themselves, which may be easily obtained throughout the greater part of the year. I will now give the most important of Lankester's* views on this subject. He says, the structure and position of the testes have not been fully made out by Claparède and other writers. The young Tubifex, a quarter of an inch in length, presents, in the ninth† fasciculate segment, a pair of pyriform protoplasmic masses, very small, hanging one on either side the nervous cord; an exactly similar pair is seen in the tenth fasciculate segment; the former are the testes, the latter the ovaries. There is only one pair of testes, not two or three, as stated by Claparède, who perhaps had not examined the youngest specimens. In the minutest details of structure the ovaries and the testes are at this period identical, consisting of nuclei scattered in a common protoplasm. After this period their development differs, for while the ova increase individually, the young sperm-cells exhibit active multiplication, by division of their nuclei into 2, 3, and 4, forming floating, spherical, aggregates of very young sperm-cells, filling the segment and dilating it into those adjacent as described by Claparède.

Lankester doubts Claparède's theory of the vas deferens being invaginated in the oviduct, and says that the manner of oviposition must be decided by further observation. He thinks also that the seminal vesicle of Claparède is probably a cement-gland, and contributes, together with the glandular wall of the vas deferens, to the formation of the spermatophores which he has elsewhere described.

Reference has been made above to an Opalinoid Parasite, which Claparède described as being frequently found in the seminal receptacles, and this conducts us to, perhaps, the most interesting part of this history. In another paper ‡ Lankester gives reasons

* Observations on the organisation of Oligochœtous Annelids, by Ray Lankester. *Annals Natural History*, 1871.

† This, it must be observed, is the tenth segment of the body, for the head is devoid of setæ. A discrepancy in this respect with Claparède is at once apparent, for he says the testes are in the ninth body segment, etc.

‡ On the structure and origin of the Spermatophores of Tubifex, by E. Ray Lankester, *Quar. Journ. Micr. Sci.*, 1871, Vol. 1, p. 180.

for the conclusion that the supposed parasitic infusorium of Claparède is not an animalcule at all, but an aggregation of spermatozoa embedded in a cementing matrix, and constituting a sperm-rope or spermatophore (Fig. 4), moulded in a spiral manner in the long neck of the seminal receptacle, and having a conical head, corresponding to an invagination in the wall of this neck at its commencement. They may sometimes, he says, be seen lying in this position in course of being moulded, and in confirmation of this he observes that in *Tubifex umbellifer*, an allied species, where the reduplication of the neck of the pouch is wanting, the spermatophores are also destitute of the conical head. The spermatozoa and the cementing matrix, he says, must be introduced in a viscid form, through the intromittent organ of one worm into the receptacle of another.

The elucidation of the various questions suggested by the foregoing would furnish ample material for a long and careful investigation on the part of any of our members who might be sufficiently interested in the subject; the observation, for instance, of the act of oviposition, which, involving as it does the question of the oviduct, would probably require much patient and continuous study, but would also clear up a great deal that is obscure in the history and organisation of these annelids. I must, however, content myself with the humbler task of taking the organs enumerated by Claparède seriatim, and making such remarks thereupon as my own imperfect observations may suggest as worthy the attention, especially of those of our members whose acquaintance with the subject may be entirely new.

The presence of the glandular cincture which surrounds the reproductive segments, presents an obstacle to the observation of the organs, not found in the other parts. It is only, therefore, by slight pressure in a compressorium, or otherwise, that they can be made out in the living state. Viewed in this manner, the testes in mature specimens may be seen to be filled with spermatozoa and sperm-cells in all stages of development, and with the application of a little more pressure, these may be made to escape, by the rupture of the body, into the surrounding water, where they will be more readily observed. The sperm-cells present the varied appearances figured in Plate 34, Fig. 5; all of which represent different stages in the development of the spermatozoa, from the primitive testis cells. These changes have been described by Bloomfield * as follows :—The primitive testis cell subdivides and becomes a sperm polyplast, which consists of a number of small cells, spermatoblasts, surrounding a larger one, the blastophore. The spermatoblasts multiply by fission whilst remaining side by side, and ultimately assume an elongated form, being that of the ripe spermatozoa. The function of the blastophore appears to be merely that of a carrier of the spermatozoa during their development, and it ultimately shrivels and perishes. Changes somewhat similar have been observed to take place through a wide range of animal forms.

The ripe spermatozoa, set free from the blastophores, escape, as Claparède says, by rupture of the testicular wall, into the perivisceral cavity of the tenth and eleventh segments, where they are taken up by the cilia fringing the funnel-shaped internal orifices of the vasa deferentia. These funnels are not very easy to make out; they may, however, be discerned just below the seminal receptacles. The ciliary tube has in addition to its coating of fusiform fibres described by Claparède, an external epithelium, as shown in Fig. 6. Although I have seen this very clearly, on one or two occasions, it is not always separable from the internal layer. The cilia which line the interior of the tube sometimes produce, by their action, a very pretty running pattern, as shown in Fig. 7. The structure and appearance of the atrium, with its seminal vesicle, as also of the intromittent organ, I will leave mainly to be gathered from Claparède's figure. I will observe of the atrium that its glandular lining, which Claparède has figured as consisting of rounded cells, would appear to me to be more correctly represented by my Fig. 8. On one occasion I found, attached to its external wall, a number of very delicate, transparent, leaf-like objects, as in Fig. 9, amongst which were others, shorter, and of a clavate form; but I have not the least idea what they were. The seminal vesicle (Lankester's cement gland), I have found to be occupied with a mass of small nucleated cells, each containing a few granules, and about one-thousandth of an inch in diameter; *a* and *b*, Fig. 10, represent the ovaries. In the former the external cells only are seen, these are in their earliest stage; others more advanced are seen in Fig. 10, *b*, to occupy the centre of the organ, and these show the germinal vesicle and spot very distinctly.

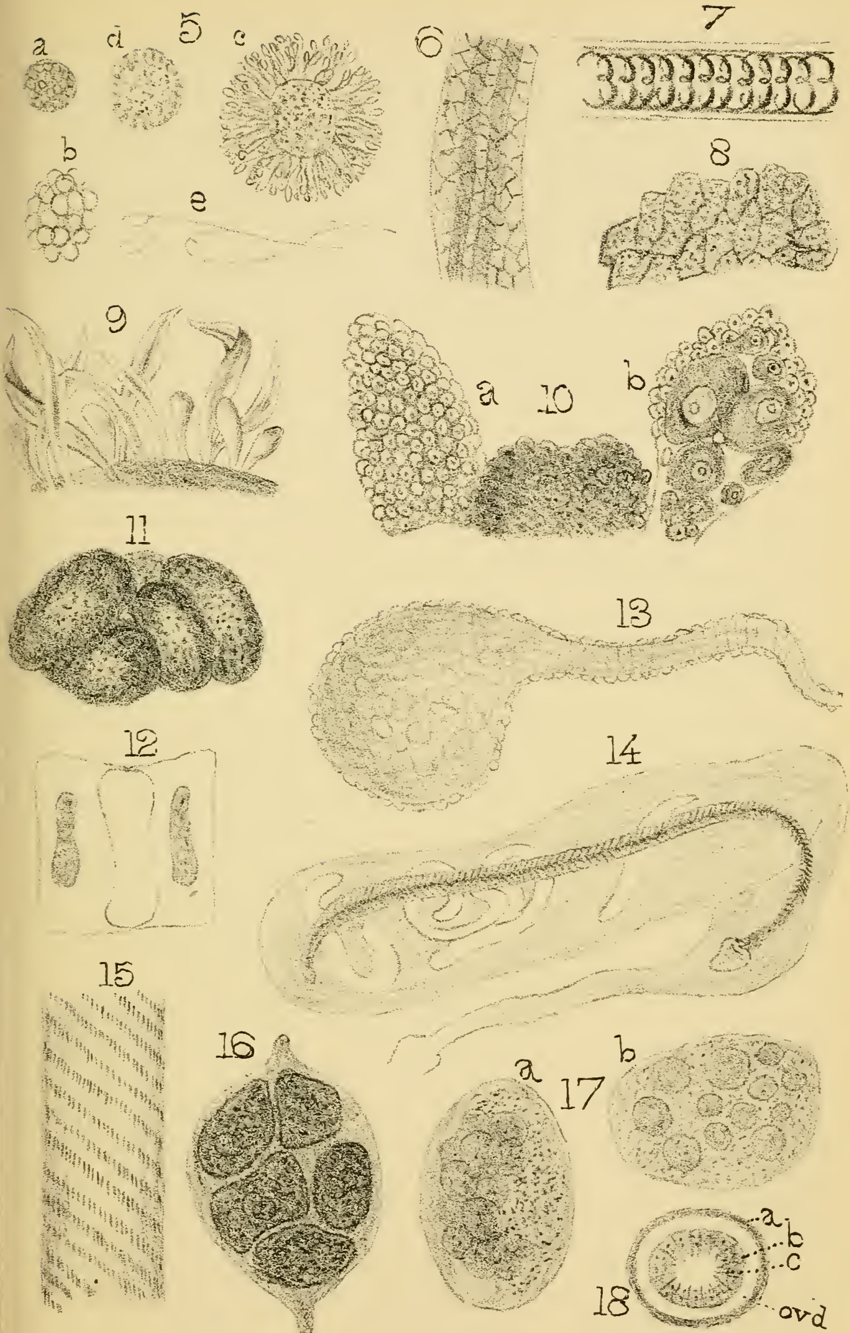
* Quar. Journ. Mic. Sci., vol. 20, 1880.

The mature eggs collected in the matrix present the appearance shewn in Fig. 11. The granular yelk is now formed, and, I think, that the four or five eggs which are thus frequently found to occupy one segment of the body, are deposited together in one ovi-capsule, as we shall see further on. They escape, according to Claparède, between the external wall of the atrium, and its inner membranous one, and in order to make this a little clearer, I have given in Fig. 18 a diagrammatic section of the atrium across the line x x in Fig. 3, where it will be seen that the oviduct thus formed has a circular section. It terminates in a bulbous organ of a brown colour, and greater hardness than the surrounding tissues; and encloses within it the intromittent organ which terminates the vas deferens. Both are placed within an inversion of the integument which forms the sexual orifice, from which however they can be exserted; the intromittent organ also can be exserted from within the bulbous termination of the oviduct. These parts are shown in Fig. 3.

The seminal receptacles found in the tenth segment are, in the earliest condition in which I have recognised them, minute sausage-shaped sacs, occupying but a small portion of the segment in which they occur (Fig. 12). Subsequently they appear as larger spherical sacs communicating, by a long neck, with the external surface of the segment (Fig. 13). Like the vasa deferentia they are, as Claparède remarks, specialised segmental organs. In this condition I can distinguish in them an external epithelium which extends along the duct, and which I look upon as a continuation of the peritoneal lining. Within this is a muscular layer of circular and longitudinal fibres, and the central cavity is occupied by free epithelial cells, derived, I believe, from the epidermis. At the period of their greatest development these sacs frequently occupy, in addition to their own, the greater part of the two segments adjoining that in which they originate. The epithelial cells with which they were formerly occupied disappear, and in their place we find the spermatophores introduced from the male organs of another worm. These, according to Lankester, are not introduced in the form in which they are found, but the cementing substance, including the spermatozoa, is introduced in a viscid form, and is subsequently moulded into shape within the sac itself. A drawing of one of these curious objects will be found in Plate 33, Fig. 4.

Sometimes the conical head is wanting, which results from the spermatophore being moulded lower down in the sac. The spermatozoa are disposed spirally within the matrix, from the surface of which they project, and maintain a constant ciliary action, giving the spermatophore the appearance of a nondescript ciliated infusorium. It is very curious that the movements of a number of perfectly independent vital elements should be so correllated as not only not to clash with each other, but to reproduce all that regularity of movement, which is seen where the ciliated surface forms part of one organic whole. Perhaps, however, remembering the separate vitality of the cell elements of the simplest protophytes, as well as of higher forms, both of animal and vegetable life, the only really curious thing is, that this rhythmical movement is reproduced as perfectly when the ciliated cells, originally separate, are brought together by a mechanical process, as when their juxtaposition arises through the ordinary processes of cell multiplication and growth. The ciliary action takes place in a series of waves, which follow each other over the surface of the spermatophore like the advancing threads of a screw (see Fig. 15). It is only on one or two occasions, however, that I have been enabled to see this phenomenon, as it is comparatively rarely that the spermatophores are found in an active condition. In by far the majority of specimens they appear to be exhausted, and in various stages of absorption; the spermatozoa, as I suppose, having worked their way out of the matrix, and the question now arises, what becomes of them? I have never been able to discern them in a free condition in the receptacles, although Claparède states that he has sometimes found them there.

The subject now appears to be encompassed with difficulties which Lankester's paper does not deal with, or even allude to. In some way or other it may be presumed the spermatozoa, having freed themselves from the spermatophore, and finding themselves within a sac-like receptacle whose only opening is external, have to make their way to the ova of the worm in which they are found. The receptacles, it will be remembered, are in the tenth segment, and the ovaries in the eleventh. To escape by the orifice


5
a
b
c
d
e
6
7
8
9
10
a
b
11
12
13
14
15
16
17
a
b
18
a
b
c
ovd

of the receptacle would be to escape into the water and be lost.

The only other hypothesis is, that they permeate the wall of the receptacle into the perivisceral cavity of the tenth segment, and thence find their way into the eleventh, and so fulfil their function. In the course of this transmigration they would inevitably become intermingled with the spermatozoa proper to the worm, a result which seems equally difficult to admit. Furthermore, a question arises, and a most interesting one, as to the function of the spermatophore. We find these objects, as I have lately had occasion to describe in the case of one of the Entomostraca, viz., *Diaptomus Castor*,* to be carriers of the seminal fluid, attached by the male to the female. But in the present case they are clearly not, as in the former, a means of transmission, inasmuch as they are formed from the seminal fluid within the female organs of the worm after copulation has taken place. It has been suggested to me that their office may be to detain the spermatozoa, and thus to regulate their diffusion in correspondence with the ripening of the ova in the next segment.

The ova, upon their expulsion, are found four or five together in tough leathery capsules, see Fig. 16, having a projection at either end. The course of their development has been described by d'Udekem as follows :—As soon as the eggs leave the body, they lose the germinating vesicle, the yelk divides into two, then into four, and when this division has resulted in a mulberry mass, a transparent zone is formed around it, which is the blastoderm, and which may be rendered clear by the addition of acetic acid. The blastoderm is composed of minute cells, and subsequently is divided into two layers, the external forming the integument, and the internal the alimentary canal of the young animal; the embryo with its various organs is then gradually formed. The projections at the poles of the capsule are softer than at the other parts, and here the young escape. They differ from the adult chiefly in the number of the segments, and the absence of the genitalia. A week suffices for the development of the eggs. Growth consists not in the addition of new rings, but in the sub-division of the last one.

* In a recent note-book of the P.M.S.

On one occasion I noticed that the eggs in the egg-cases were sometimes filled with, as yet, unsegmented granular yelk. Others, especially when submitted to the action of acetic acid, showed a mulberry-like mass of cells, the morula, as Claparède states, but this was confined more particularly to one side of the egg, and some of the original granular yelk was still associated with it, as seen in Fig. 17, *a*; this I take to indicate a stage of yelk-division preceding the formation of the blastoderm, and that the division does not proceed equally in all parts, but that a portion is left unsegmented, forming what is called food-yelk; this being gradually used up by the growth of the embryo. The yelk-division, in fact, is what is termed incomplete. The addition of glycerine instead of acetic acid renders the co-existence of cellular and granular contents in the eggs at this stage very clear, but the cells become separated from each other instead of cohering in a mass as before (see Fig. 17, *b*).

I cannot conclude this paper without quoting a passage from Gegenbaur's Comparative Anatomy, which I have just seen, and which seems to contradict Lankester's statement that the spermatophores are formed within the seminal receptacles. He says (p. 191):—"In many Annulata the seminal filaments are united into masses of definite forms (spermatophores) *in special parts of the male efferent ducts;* these are passed *as such* into the female apparatus. Many *Scolecina* have spermatophores of this kind, which are merely formed by agglutinated seminal filaments (Tubifex)." As this was published in 1878, the author might be, and very probably was, acquainted with Lankester's paper.

EXPLANATION OF PLATES XXXIII. & XXXIV.

PLATE XXXIII.

Fig. 1.—Diagram representing the position of reproductive organs of Tubifex, according to Claparède. The segments are marked with Roman numerals. *t.*, the testes; *ov.*, the ovaries; *ova*, mature ova in matrix; *f.*, the funnels; *t.c.*, the ciliary tube; *at.*, the atrium; *s.o.*, the sexual orifice; *v.s.*, vesica seminalis; *s.r.*, the seminal receptacles; *i.*, the intestine.

,, 2.—Fusiform fibres of ciliary tube (Clap).

Fig. 3.—Vas deferens (Clap.): *f.*, the funnel; *t.c.*, the ciliary tube; *at.*, the atrium; *v.s.*, the vesica seminalis; *r.*, the thickened rim of outer coat of atrium, giving passage to neck of vesica seminalis, and allowing eggs to pass into the oviduct; *s.o.*, the sexual orifice; *od.*, extremity of oviduct, enclosing *i.o.*, the intromittent organ.

,, 4.—Spermatophore.

PLATE XXXIV.

,, 5.—Sperm-cells and spermatozoa. Of these *a* is, I believe, the earliest condition, and shows sub-division of primitive testis-cell; *b* is a sperm polyplast, and shows the spermatoblast surrounding the blastophore; *c* shows a blastophore, surrounded with spermatozoa, the result of the fission of the spermatoblast; *d* is probably a blastophore from which the spermatozoa have become detached; *e*, mature spermatozoa.

,, 6.—Portion of ciliary tube showing external epithelium.

,, 7.—Pattern formed by ciliary action in tube.

,, 8.—Glandular lining of atrium.

,, 9.—Leaf-like objects attached to atrium.

,, 10.—Ovaries: *a*, external cells; *b*, internal ditto.

,, 11.—Cluster of mature eggs from matrix.

,, 12.—Seminal receptacles, early condition.

,, 13.—Ditto, more advanced, showing muscles and epithelial coat, and contents.

,, 14.—Ditto, mature, and enclosing spermatophores.

,, 15.—Portion of spermatophore showing ciliary waves.

,, 16.—Egg capsule, with eggs.

,, 17.—Egg from capsule: *a*, prepared with acetic acid; *b*, with glycerine.

,, 18.—Section of atrium in the line × ×, Fig. 3, showing, according to Claparède, *a*, the thick external wall; *b*, the inner membranous wall; *c*, the epithelium; the space *ovd* represents the section of the oviduct.

The Eye.

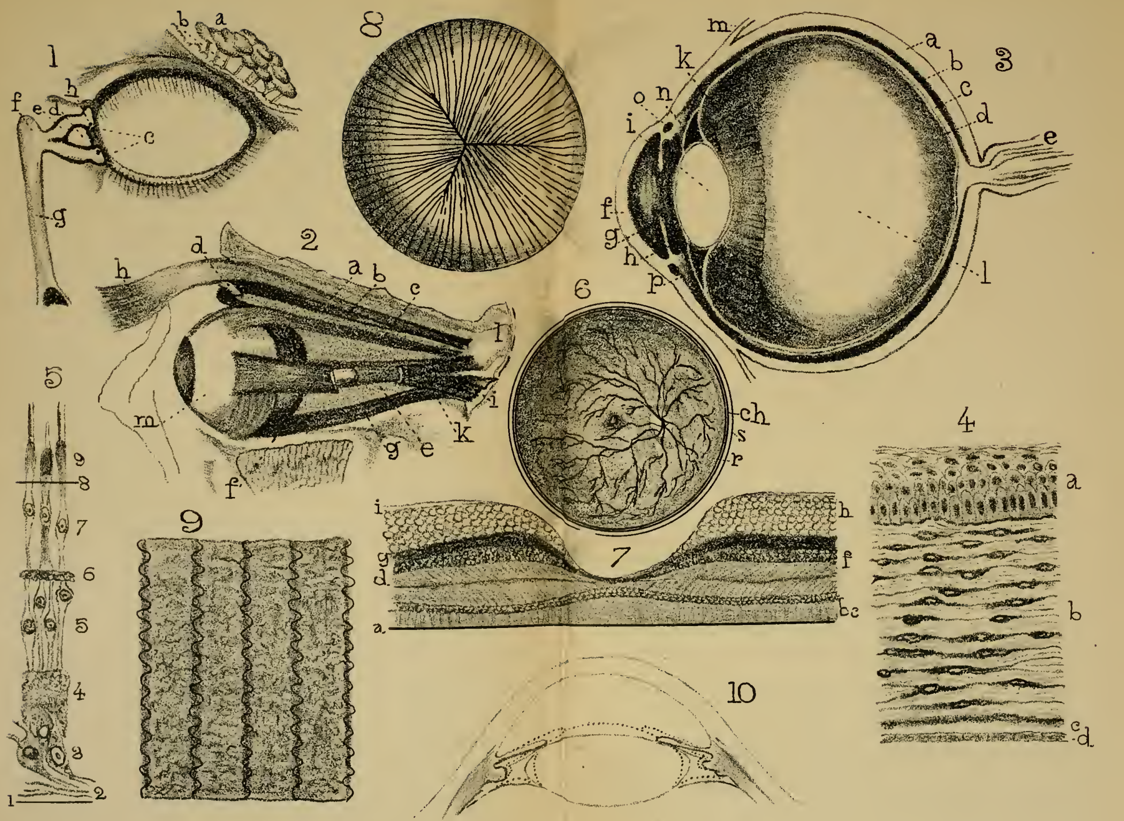
BY MALCOLM POIGNAND, M.D. Plates 35 and 36.

THE present paper is an outline of the anatomy and physiology of the human eye, with an occasional reference to comparative anatomy. This, I trust, may prove of interest to those who have not much technical knowledge.

The eyes of man are placed as far as possible in safety in bony sockets or orbits. In examining a skull, we cannot fail to have noticed the thickening of the bones at their margins, and the strength of the arches there formed. In many pre-historic races they were much thicker than, with rare exceptions, they are now, and resembled the great ridges and crests which protect the eyes of the male Gorilla.

In some blind mammals, with only rudimentary eyeballs, such as the Italian and the Cape Moles, no eyelids exist, and in these animals the skull shows no trace of an orbit, and the malar bone (which generally forms and protects a large part of the orbit) is, as a rule, either entirely wanting, or very rudimentary. Just as with those deep-sea crustaceans, whose cephalo-thorax shows no sign of an eye or trace of eye-stalk, and whose downward career can be traced step by step from their light-appreciating ancestors: much the same thing has happened in the great mammoth caves in America to the spiders, beetles, etc., living there.

In man relatively is the orbit best developed, and from its position and character you might predict that he would not as a rule depend on flight for safety, but would turn and face the danger, unlike most ruminants and timid rodents, whose prominent and laterally-placed eye can glance behind as easily as in front, without a turn of the head. The eyebrows divert the otherwise irritating stream of perspiration which toil or heat wring from the forehead; the eyelashes help to guard against insects and other small bodies, and the eyelids close accurately and swiftly by involuntary reflex action at the near approach of a foreign body. Often, indeed, no effort of the will, however strong, or determination well grounded and reasonable, is sufficient to restrain this action. Dr. Darwin mentions how, when watching a poisonous snake in its cage, which had a thick plate-glass front, he never could restrain a blink and a wince when the angry reptile shot forward its head to strike him, not realising the intervening glass against which his face was pressed. However, should any foreign body reach the exposed surface, the epithelium of the eye or *conjunctiva* is so abundantly supplied with sensitive nerves, that their irritation speedily produces a copious secretion of tears from the lachrymal gland, in order that the foreign body may be


1
a
b
c
d
e
f
g
h
2
a
b
c
d
e
f
g
h
i
k
l
m
3
a
b
c
d
e
f
g
h
i
k
l
m
n
o
p
4
a
b
c
d
5
1
2
3
4
5
6
7
8
9
6
ch
s
r
7
a
bc
d
f
g
h
i
8
9
10

removed. In ruminants the upper portion is ciliated. The cilia are especially long in the Giraffe, whose eyelid, margin, and *conjunctiva* are deeply pigmented, as also the Kangaroo, the frequent involuntary movements of the lids aid in keeping the surfaces moist.

The *lachrymal* gland (Plates 35 and 36, Fig. 1, *a*), under ordinary circumstances, only secretes about sufficient fluid to moisten the surface of the *conjunctiva* and eyelids, and with the secretion of the *Meibomian follicles*, to prevent friction between them in their rapid movements. The surplus being carried off by two small canals (*c*), which open at the inner corner or *canthus* of the eyelids by two puncta, and unite at the *lachrymal sac (f)*, through which the tears flow into the nasal cavity along the nasal duct. The small fold (*plica semilunaris*), (*h*), and vascular protuberance (*caruncula*), (*d*), at the inner canthus, are all that remain in man and apes of the third or nictitating lid, and its lubricating (*Harderian)* gland. These have been well developed in birds. Fish have no need of, and therefore have no *lachrymal* gland. Crocodiles have extremely complex appendages to their eyes.

Tears in all nations are viewed as a sign of grief or pain. Amongst civilised races, the tears which flow from a sudden joy, are probably due to the sudden removal of restraint. Not so in some ancient races of mankind, who have either sunk below or have never raised themselves up to the level of more civilised nations, such as the Andamanese.

In the interior of the orbit we find that which is, roughly speaking, a quadrilateral, pyramidal cavity, with the apex directed backwards and slightly inwards, and with openings at and near the apex for the optic nerves and vessels passing forwards. Through the optic foramen, at the apex, passes the optic nerve, which takes an additional sheath from every membrane through which it travels.

From the margin of the bone adjacent arise the four Recti muscles, named respectively Superior, Inferior, External, and Internal (Fig. 2, *c.e.f.g.*). The *Levator palpebræ*, (*a*), arises in the same manner, and is inserted into the fibro-cartilage of the upper eyelid, which its action raises. The superior-oblique muscle, (*b*,) has also its origin here, but passing forwards along the upper part of the inner side of the orbit, it takes its course through a fibro-cartilaginous pulley (*d*), lined by a delicate synovial membrane to prevent friction, and its tendon leads outwards and backwards, and expands to its insertion into the globe, which, by its action, it rolls on its antero-posterior axis. Its opponent muscle, the inferior-oblique, is placed below, and is short, and arising from the bone of the inner and lower front corner of the orbit. The action of these last two muscles is required for the correct viewing of an object when the head is moved laterally, as from shoulder to shoulder.

Passing on to the eyeball itself, the globe (Fig. 3) is composed of three investing tunics—

1. Sclerotic and Cornea;
2. Choroid, Iris, and Ciliary processes;
3. Retina;

And three fluid and solid refracting media—

Aqueous;
Crystalline (Lens) and Capsule;
Vitreous.

The **Sclerotic**, Fig. 3 (*a*), as its name implies, is extremely dense and hard, being composed of firm, unyielding, fibrous tissue, mixed with some elastic fibres. It serves to maintain the form of the globe, and is much thicker behind than in front, the principle strain from pressure applied in front falling behind, and this is the main reason of the enormous relative thickening of the sclerotic in the eye of the whale. Besides, in front, the tendons, being closely applied, strengthen and protect the cornea, and posteriously, the extremely sensitive portions of the retina require protection from any disturbance.

The **Cornea**, Fig. 3 (*f*), is the projecting, transparent part of the external tissue of the eyeball, and forms the anterior sixth of the globe. Its degree of curvature varies in different individuals, and is more prominent in youth than in advanced life. The cornea is dense and uniform throughout. It is not circular, even in the human eye. According to Cuvier, the vertical chord of the cornea is ·46 inch, while the horizontal chord is ·49.

The curvature of the cornea is different in the eyes of other creatures. For example, M. Chossat found that the cornea of the eye of an ox was an ellipsoid of revolution round the greater axis, this axis being inclined inwards about 10°. The ratio of the major axis to the distance between the foci in the generating ellipse he found to be 1·3; and this agreeing very nearly with 1·337, the index of refraction of the aqueous humour, it follows from the laws of light, that parallel rays will be refracted to a focus by the surface of this humour with perfect accuracy.

He also found that the two surfaces of the crystalline lens are ellipsoids of revolution round the lesser axis; and it is somewhat remarkable that the axes of these surfaces do not coincide in direction with each other, or with the axis of the cornea; these axes being both inclined outwards, and containing with each other, in the horizontal section in which they lie, an angle of about 5°. The same author found that the cornea of an elephant's eye is an hyperboloid.*

The cornea consists of five layers:—Conjunctiva; Anterior elastic layer; Fibrous layer, arranged in layers; Posterior elastic layer; Endothelium.

The **Choroid**, Fig. 3 (*b*), is the vascular tunic of the eye, and is stained in man with a deep brown or black pigment. The outer surface is flocculent through the attachment of the cellular tissue uniting it with the sclerotic. The inner surface is smooth, and is covered by a layer of densely pigmented, and more or less hexagonal cells, beneath which it is highly and minutely vascular. The substance of the choroid is mainly formed of the ramifications of the arteries and veins, and is traversed by the ciliary nerves on their way to the *iris*.

On the outer and anterior border of the choroid is a circle of grey, softish substance, mainly the ciliary muscle, applied like a band round the margin of the aperture, into which the *iris* is fitted. It adheres closely to the sclerotic at the line of the junction of the cornea. This zone is called the *ciliary ligament* (*n*). On the inner border of the choroid is a circle of longitudinal folds of that membrane, called *ciliary processes* (*k*). The free central or internal border of each fold enters into the contiguous

* Lloyd on "Light and Vision."

hyaloid membrane round the circumference of the crystalline lens, which hyaloid membrane is continuous with the fibro-cellular elements of the retina, which ends at the *ora serrata* (about one-third back from front). The anterior ends of the processes project into the posterior chamber of the aqueous humour, touching the *iris*, and bounding peripherally that chamber.

The **Iris**, which receives its name from the various colours it assumes in different individuals, is the circular screen, or curtain, attached at its outer border to the ciliary ligament, and interposed between the cornea and lens. Its aperture is commonly spoken of as the pupil. Its anterior surface is the seat of that variety of colour to which, in common parlance, the colour of the eye itself is attributed. At birth the anterior surface of the *iris* is invariably blue, at which time this colour does not depend on pigment, but is due to interference phenomenon in the same manner as the blue of the sky. Pigment begins to be deposited a few weeks after birth. The posterior surface is covered with pigmented cells. Albinoes are an exception, and have no pigment anywhere, and so, in their pink eyes, the colour of the blood is shown up ; the light reflected back from the interior of the eye, being absorbed in others by the pigment. The substance of the *iris* contains involuntary muscular fibres near its free edge, forming a circular band, and closing by its contraction the pupil ; it also contains fibres acting as dilators, radiating outwards from the central band.

The **Retina**, Fig. 3 (*c*).—On entering the orbit, the optic nerve, protected by an additional sheath (derived from the *dura mater*), after a slightly curved course, enters the globe slightly to the nasal side of the posterior pole. The outer sheath blends with the sclerotic, and the inner one ends at the *lamina cribrosa*, as the sieve-like opening in the sclerotic is called, so that the nerve fibrils only enter quite transparent, and accompanied by the artery of the retina and its veins. The uncovered nerves bend round, and end in the layer of ganglion cells of the retina as far as the *ora serrata*. The artery sub-divides and breaks up in the granular layers into a very fine set of capillaries.

The drawing (Fig. 3) shows what is believed to be the arrangement of parts in the retina; very little, if anything, is known about the action in any layer. But the whole acts much as a thermopile of bismuth and antimony. The thermopile changes certain waves of radiant energy, which we call heat, into electricity. The retina changes certain waves of radiant energy, which we call light, into electricity of some sort, which runs along the nerves, by means of which the brain receives impressions. Exactly in the centre of the posterior part of the retina, and at a point corresponding to the axis of the eye, in which the sense of vision is most perfect, is a round, elevated, yellowish spot, called the Yellow spot of Sömmerring, having a central depression at its summit, called the *fovea centralis* (Fig. 6). The retina, in the situation of the *fovea centralis*, is exceedingly thin (Fig. 7), so much so, that the dark colour of the choroid is distinctly seen through it. It exists only in man, the quadrumana, and some saurian reptiles. About one-tenth of an inch to the inner side of the yellow spot in the human eye, is the entrance of the optic nerve, the artery piercing its centre (Fig. 6). This is the only part of the surface of the retina from which the power of vision is absent.

The aqueous humour fills the anterior and posterior chambers of the eye-ball, as shown in Fig. 3. It is scarcely more than water, with a trace of salt. Endothelium has only been demonstrated on the inner surface of the cornea, but it probably exists on the surface of both posterior and anterior chambers; especially in the fœtus, where the two chambers are separate, the pupil being closed by a membrane.

The **Vitreous body** forms about four-fifths of the entire globe, it fills the cavity of the retina, and is hollowed in front for the reception of the lens and its capsule. It is perfectly transparent, of the consistence of thin jelly, and consists of an albuminous fluid enclosed in a delicate, transparent membrane, known as the *hyaloid*.

The **Crystalline Lens**, enclosed in its capsule (Fig. 3, *i*), is situated immediately behind the pupil, in front of the vitreous body, and surrounded by the ciliary processes (*k*), which slightly overlap its margin.

The structure of the crystalline lens is very complex. It consists essentially of fibres united side by side to each other (Fig. 8), and arranged together in very numerous laminæ, which are so placed upon one another, that when hardened in spirits the lens splits into three portions in the form of sectors, each of which is composed of superimposed concentric laminæ. The lens increases in density, and consequently in power of refraction from without inwards, the central part, usually called the nucleus, being the most dense. The individual fibres dovetail laterally into each other, something after the fashion of those of the cod (see Fig. 9). According to Dr. Brewster and Dr. Gordon, the refractive indices of the outer coat, the middle, and the central parts, are 1·3767, 1·3786, and 1·3999 respectively. This increase of density serves to correct the aberration by increasing the convergence of the central rays more than that of the extreme parts of the pencil.* The lens is believed to be kept slightly compressed and flattened out by the tension of its elastic capsule. The ciliary muscle (*n*), by its action on the hyaloid membrane, reduces this tension, and the movements which ensue are thought to be those which take place when the eye is accommodated for near vision.

The normal condition of the eye is for sight of distant objects (Fig. 10). The accommodation is extremely rapid from near objects to distant ones, but comparatively slow from distant to near; the alteration, depending on the recoil of the elastic tissues, being swift as compared with the slow construction of the involuntary muscular fibres of the ciliary muscle. If it be so arranged that the recoil should take place in the dark, the resulting shock is sufficient to produce the sensation of a flash of light, like that caused by a blow.

In spite of what a late writer has said with regard to the incompleteness of the eye, we must look upon it as an example of consummate wisdom and perfect adaptation to the ends it is designed to serve. That there is a great deal more to be learned by us in its structure, and especially in that of the eyes of other creatures, we must all feel to be the case. The inferior animals are probably able to appreciate rays of light which

* Lloyd on "Light and Vision."

do not make any impression upon the eyes of man, and their eyes are constructed accordingly. How extremely curious, for example, are the 4,000 facets in the eyes of the common House-fly, each one of which is a lens capable of forming a perfect image; and how strange to find that these are not sufficient, for there are three ocelli in addition, each a single eye, and differently placed in the head! And all of these are provided with those rods and cones which are also found in our own eyes, and which seem to render the optic nerve sensitive to rays of various vibrations. How vast a field of enquiry and investigation still remains almost unsearched, almost unknown, in the eyes of man, and of other creatures!

If this paper will be in any degree an incentive to further search, it will not have been written in vain. The space at our disposal is too limited to go into the physiology of the eye at any considerable length; but such may form the subject of some future paper.

Owen's Comparative Anatomy, Riche's Physiology, and Gray's Anatomy have been principally consulted in writing the above paper.

EXPLANATION OF PLATES XXXV. AND XXXVI.

Fig. 1.—The Lachrymal Apparatus :—
a, Lachrymal glands. *b*, Ducts. *c*, Puncta Lachrymata. *d*, Caruncula Lachrymalis. *e*, Canaliculi. *f*, Lachrymal sac. *g*, Nasal Duct. *h*, Plica semilunaris.
The upper and lower eyelids are also shown.

,, 2.—Muscles of the Eye :—
a, Levator palpedræ, upper. *b*, Superior oblique. *c*, Superior Rectus. *d*, Pulley. *e*, Internal Rectus. *f*, External Rectus. *g*, Inferior Rectus. *h*, Tarsal cartilage. *i*, Upper Head of internal recti. *k*, Lower Head. *l*, Lesser wing of Sphenoid. *m.*, Sclerotic.

,, 3.—Vertical Section of Eyeball :—
a, Sclerotic. *b*, Choroid. *c*, Retina. *d*, Hyaloid Mem brane. *e*, Optic Nerve. *f*, Cornea. *g*, Anterior Chamber of Iris. *h*, Posterior Chamber of same. *i*, Lens in its Capsule. *k*, Ciliary processes. *l*, Cavity occupied by vitreous humour. *m*, Tendon of Rectus. *n*, Ciliary Muscle and Ligament. *o*, Circular Sinus. *p*, Canal of Petit.

,, 4.—Vertical Section of Cornea of Rabbit, hardened in chromic acid :—*a*, Anterior layer of pavement of epithelium. *b*, *Substantia propria* of the Cornea, consisting of connective tissue fibres in more or less parallel bundles, between which are the Cornea corpuscles; these, in vertical sections, appear spindle-shaped. *c*, The posterior *Lamina elastica*, or Descemet's membrane. *d*, The Endothelium of polyhedral cells which covers it.

Fig. 5.—Diagram of the nervous elements of the Retina (after Max Schultze):—
1, The *Limitans interna.* 8, The *Limitans externa.* 2, Layer of nerve fibres. 3, Layer of ganglion cells. 4, Inner finely granular, or, more correctly, finely fibrillated layer, which forms an extremely close network of very fine fibres, into which, on the one hand, the processes of the ganglion cells penetrate; out of which, on the other hand, the fibres of the inner granular layer, 5, proceed. The outer processes of the elements of this layer similarly terminate in a close, finely fibrillar network; 6, the intermediate granular layer, or outer finely granular, or, more correctly, finely fibrillar layer. Out of this proceed the inner processes of the outer granular layer, 7, whch terminate as rods and cones, 9.

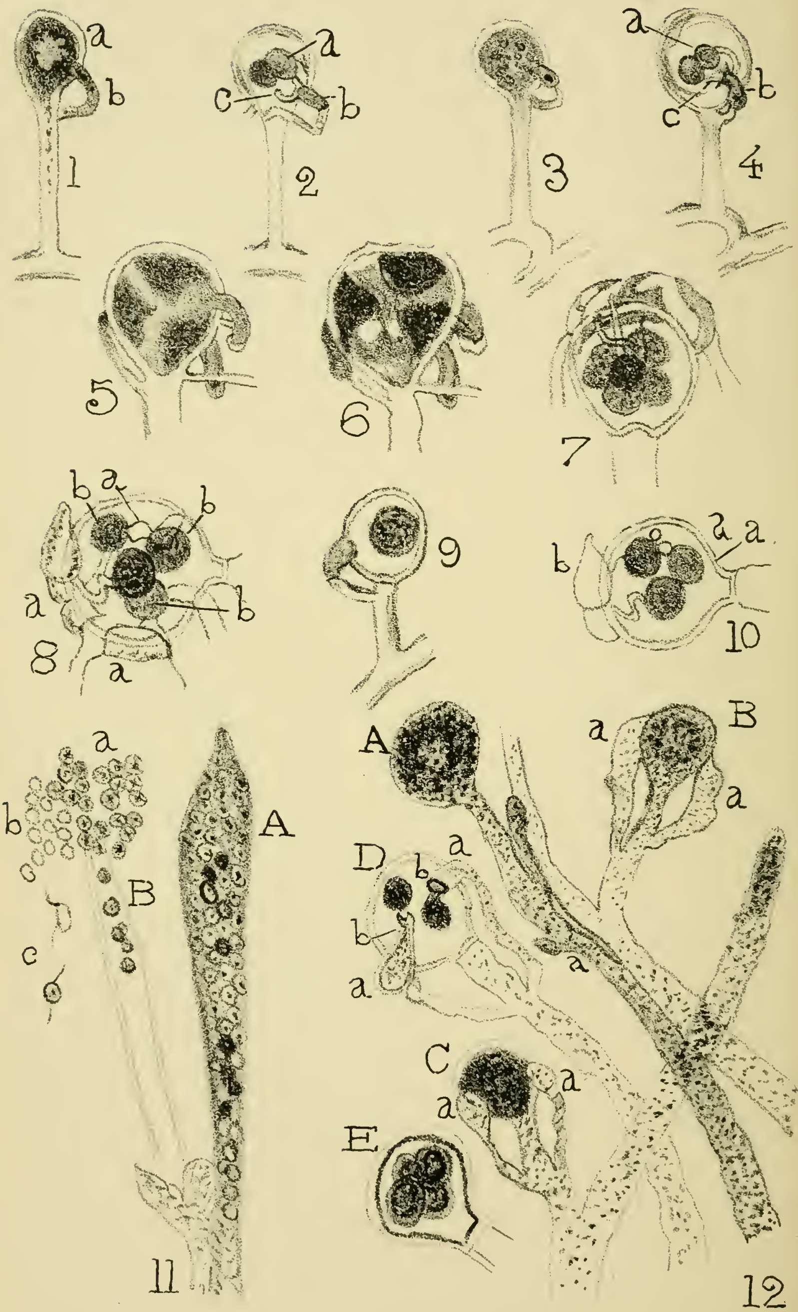
,, 6.—The posterior half of the Retina of the right eye, viewed from before (after Henle):—*s.*, the cut edge of the Sclerotic Coat; *ch.*, the Choroid; *r.*, the Retina; in the interior at the middle, the *Macula lutea*, with the depression of the *Fovea centralis*, is represented by a slight oval shade; towards the right side, the light spot indicates the *colliculus*, or eminence, at the entrance of the optic nerve, from the centre of which the *Arteria centralis* is seen spreading its branches into the Retina, leaving the part occupied by the *macula* comparatively free.

,, 7.—A diagrammatic section of the *Macula Lutea*, or yellow spot: *a*, the pigment of the Choroid; *b c*, rods and cones; *d*, outer granular layer; *f*, inner granular layer; *g*, molecular layer; *h*, layer of ganglionic cells; *i*, fibres of the optic nerve, mag. about 60 diameters.

,, 8.—Arrangement of fibres of Lens in the Mammalia.

,, 9.—Fibres of the Lens in Eye of Cod-Fish.

,, 10.—Diagram representing, by dotted lines, the alteration in the shape of the Lens, on accommodation for near objects.


1
2
3
4
5
6
7
8
9
10
11
12
a
b
c
A
B
C
D
E

On the Saprolegnieæ.

By George Norman, M.R.C.S.E., etc.

Plates 37, 38.

THE Saprolegnieæ are colourless parasites usually found attached to animal or vegetable organisms in water; they are now regarded as fungi, closely allied to the Mucors or Moulds. Two of the principal divisions of the group, *Achlya* and *Saprolegnia*, have certainly been known for many years, although nearly always described by the early writers as Confervæ or Algæ.

In the year 1821, we find a description by Gruithuisen of a plant found on a dead water-snail, which he called *Conferva ferax*, and which, from the description given, was evidently a Saprolegnia. In 1823, Saprolegnia is certainly described by Carus, who speaks of it as a mouldy growth, and refers it to the *Hydronemata*, a proposed class of plants intermediate between Algæ and Fungi. In 1831 Nees refers to it, and in 1839 we have a paper by Hannover entitled "On a Contagious Conferva growing upon the Water-Salamander." Meyer, commenting upon this paper, in the same year, remarks that the plant is *Achlya prolifera*, and justly regards the contagious character as an ordinary propagation of the plant by spores. In 1841, we have a description by Dr. Stilling, of Cassel, of a Contagious Confervoid growth on living frogs; and in the next year a paper entitled "Further Illustrations of the Contagious Confervoid Growth on Frogs and Water-Salamanders," by Hannover. The latter was in opposition to the essay of Stilling, who was inclined to place this parasite in the Animal Kingdom. In both cases the descriptions and drawings leave no doubt that the plant described was Saprolegnia. In 1844, Unger gave an explicit account of the parasite, which had proved very destructive to the Carp in the tanks of the Botanical Gardens at Gratz; he also met with it on sickly Goldfish. In Vol. IX. of "The Annals of Natural History," is an article by J. Goodsir, entitled "On the Conferva which vegetates on the skin of a Goldfish," giving a good description of Saprolegnia.

The Rev. M. J. Berkeley, in his "Introduction to Cryptogamic Botany," places the Saprolegnieæ amongst the Algæ, but speaks of them in the following words :—" The globular sporangia . . . with their spores resemble so closely those of some of the Mucorine Fungi, that I should not hesitate, were there any other instance of the production of zoospores with flagelliform appendages amongst Fungi, about their removal from Algæ." And in another place, when describing the Mucorine Fungi, he says :— " The aquatic moulds which have been described under Algæ will in all probability find their resting-place here, and, if so, will present the singular anomaly of true zoospores amongst Fungi." Recent investigation has fully confirmed the accuracy of this conjecture, and has also demonstrated that Saprolegnieæ is by no means the only group of Fungi amongst which true zoospores are to be found.

We have now to consider the development and structure of this fungus so far as it is at present known, for it still presents a wide field for enquiry. The first point to be noticed is the probable relationship that exists between the *Saprolegnieæ* and the parasite called *Empusa Muscæ*, a member of the order *Torulacei*, which proves fatal to house-flies in the autumn. The mycelium bores through the cuticle of the living fly, and immediately breaks up into short joints, which diffuse themselves through the body of the fly, and everywhere multiply by division, until they have appropriated all the nutritious matters which are available to them, and the fly becomes covered with a powdery substance, which consists of extruded conidia. These conidia are capable of forming secondary conidia, which would infect other flies, and, in turn, give rise to fresh conidia in the bodies of their hosts. But should such a diseased fly fall into water and remain there, it soon developes a filmy mouldiness around it, which rapidly increases till the fly appears to be enclosed in a white fluffy ball, and on microscopic examination this ball is found to consist of a fungus indistinguishable from Saprolegnia.

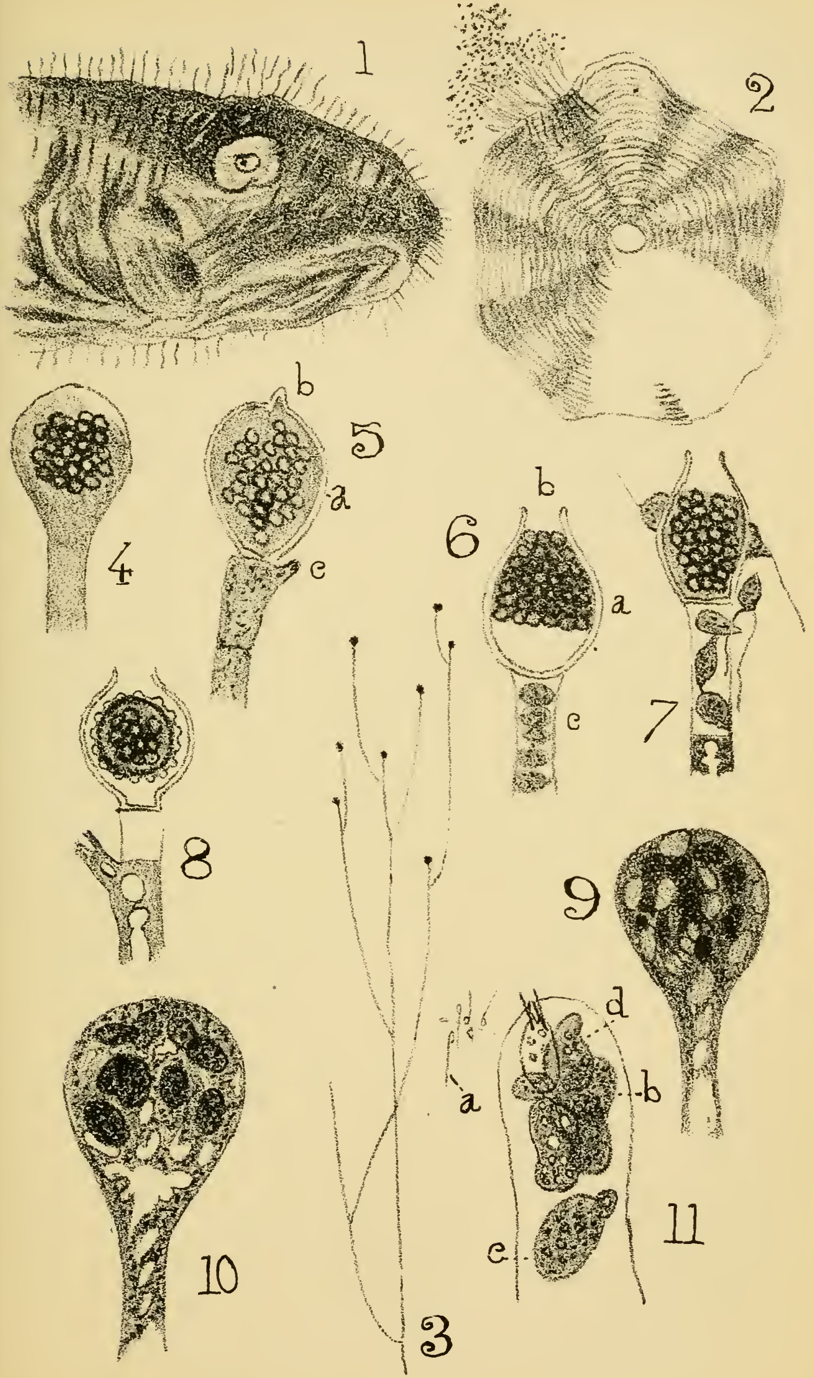
No researches have as yet been made on this subject, but the following points are worthy of consideration :—The process of reproduction in Fungi may be either asexual or sexual. It is said to be *asexual*, when a part of the plant which becomes detached is able, without the assistance of any other organ, to produce a new individual. Of this nature are the conidia of *Empusa.* It is said to be *sexual*, when two cells, developed expressly for the purpose, combine, either by complete coalescence or by partial intermingling of their contents, to produce a body out of which one or more new individuals arise. But these two kinds of reproduction may occur in the same individual, or may be distributed in different individuals, and in both cases the entire process of development may be divided into two sharply separated stages. At the termination of one stage sexual organs are formed; by their union the second stage of development is rendered possible, and this closes with the production of asexual spores. Such a course of development is termed, from the analogy of certain processes in the animal kingdom, an "Alternation of Generation," and is especially applicable when, in one or both stages of development, multiplication also takes place by conidia.

As regards the structure and development of *Saprolegnia*, there is, first of all, the felted mass of mycelium common to all fungi. From this grow filaments, called "hyphæ," which are tubular, thin-walled, and lined by finely-granular protoplasm. The ends of some of the hyphæ become enlarged to form the spore-cases, in which protoplasm accumulates, and the cavity is shut off by a transverse partition. In a short time, the protoplasm breaks up into little spheroidal bodies, which form the spores, or rather zoospores, for under certain circumstances they are actively locomotive, after the fashion of many animalcules. When the zoospores are perfectly developed, the apex of the spore-case, or "Zoosporangium," opens and the zoospores are emitted. Each zoospore, as it leaves the zoosporangium, is usually in active motion, being propelled by the rapid lashing of two vibratile cilia, which are attached to one point of its surface. After a few minutes it becomes quiescent, and surrounds itself with an extremely delicate transparent coat. But this repose is of very short duration, as it soon emerges from its envelope, and moves about even more actively than before. It has now an elongated, oval, or kidney shape, and has two cilia, which proceed from one side of the oval. This second active state may last for a day or two, but sooner or later the zoospore comes to a state of rest, which is final, and then usually germinates.

The growth and development of *Saprolegnia* takes place with extraordinary rapidity. In thirty-six hours from the first infection with the spores, a thick growth of the fungus has arisen, and by the third day a thousand hyphæ may have developed and emptied their sporangia, setting free some twenty thousand zoospores, each of which is competent to set up the same process afresh. About the fourth day, the zoosporangia diminish in number, and dictyosporangia make their appearance. In this form of sporangium there is no exit for the spores. They encyst themselves, and often germinate within the spore-case. Not unfrequently about this time, the hyphæ tend to break up into short joints, which are themselves capable of germination.

After the sixth day, a new kind of sporangium makes its appearance, which is termed an "Oosporangium," inasmuch as the spores to which it gives rise are more like eggs or seeds than the products of the other kinds of sporangia. The summit of a hypha dilates into a spheroidal sac, the cellulose wall of which becomes thickened, but presents here and there thin places, looking like clear, circular dots or apertures under the microscope. Protoplasm accumulates in the spheroidal case thus formed, and either remains a single, rounded mass, or divides into a smaller or greater number of spheroids, each of which, much larger than a single zoospore, is termed an "oospore." About this time, slender, twig-like branches are given off, either from the stalk of the oosporangium, or from an adjacent hypha, and the terminal portion of one or more of these twigs applies itself to the oosporangium. This terminal portion becomes shut off from the rest of the twig by a transverse septum, and is an "Antheridium." The antheridium pierces the wall of the oosporangium, at the clear spots or apertures before mentioned, and divides into branchlets, which apply themselves to the oospores. Antherozoids then pass from the antheridia into the oospores, and effect fecundation.

Two other remarkable facts have still to be mentioned. In the first place, that determined by Pringsheim—viz., that parthenogenesis is not an uncommon phenomenon in Saprolegnia. Some, or even all, of the oogonia on a plant may not be fertilised at all, the formation of antheridia on them being altogether suppressed; nevertheless, the unfertilised oospores germinate, and


1
2
4
5
a
b
c
6
a
b
c
7
8
3
9
10
11
a
b
c
d

produce new Saprolegnieæ, apparently just as well as if they were fertilised. In contrast to the development of oospores without fertilisation, is the occurrence of antheridia, the tubes of which do not penetrate into the oogonia, but open and expel the fertilising particles into the surrounding water.* The fertilised oospores clothe themselves with a thick, firm cell-wall, and remain dormant in the oogonium for months. These are the resting-spores, which fall off, sink to the bottom of the water, and rest through the winter. Thus nature has provided against all the zoospores being destroyed by a hard winter and the fungus extirpated, by enclosing from five to twenty in a thick, tough skin or shell, which rests quietly in the water until the return of spring.

This account of the development of the Saprolegnieæ applies generally to the whole group; but there are various details to be noticed, by which the different genera are recognised. The difficulties attending the identification of the various genera are many, for, as is now known, the generic characters seem to depend on the mode of formation and evolution of the zoospores, and the specific characters on the conditions of the sexually-developed reproductive organisation, and on the special figure of the oogonia. Hence, unless one be successful in finding one of these plants in a sufficiently early condition to gain a view of the formation of the zoospores, which ordinarily precedes the true fructification, its generic position cannot be definitely predicated. On the other hand, if one sees the zoospores only, and thus establishes the genus, but fails to get a view of the conditions of the other type of fructification, the species to which any particular plant belongs must remain undetermined.

The following are the principal genera, with their special characteristics :—

1.—SAPROLEGNIA. In *Saprolegnia*, when the zoospores have escaped from the apex of the sporangium, a new spore-case is developed from the septum, and grows up within the old case.

* These observations on the fecundation of the oospores are on the authority of Cornu, who in 1872 published an exhaustive monograph on the Saprolegnieæ, but De Bary, after more recent and prolonged researches, has come to the conclusion that, although the fertilising tubes of the antheridium do in some cases enter the oogonium, yet they always remain closed at the end, and never enter the substance of the oospores, and that no observable passage of anything takes place through the fertilising-tubes.

The sporangia are terminal, and the zoospores are primordial cells. Oogonia polysporous and terminal.

2.—ACHLYA. In *Achlya* the sporangia are lateral, and the new sporangia are also developed laterally from beneath the septum. The zoospores are the products of a number of special mother-cells, formed in the sporangium from its contents. Oogonia polysporous.

3.—APHANOMYCES. The sporangia are thinner and more elongated than in the other genera, and the zoospores are in single file within them. Oogonia monosporous.

4.—PYTHIUM. The sporangia are inflated at the extremity into a bladder, in which protoplasm collects, and from which the zoospores are developed. Oogonia monosporous and not quite terminal, being often surmounted by a little cylindrical portion of the filament.

5.—LEPTOMITUS. The sporangia consists of pouches not partitioned off, but furnished here and there with constrictions; otherwise it corresponds very much with *Saprolegnia*.

6.—MONOBLEPHARIS. The filaments of this genus are remarkable, in that they give no reaction with sulphuric acid and iodine, showing the absence of cellulose. The antherozoids are formed in small spore-cases, which burst and allow them to disperse through the water.

It is a curious fact in the history of parasitism that the *Saprolegnieæ*, which are themselves essentially parasitical, should in their turn be the subjects of a parasitic growth, in the shape of a very minute fungus belonging to the group *Chytridineæ*. This group is very probably allied to the *Myxomycetes*, for there are several remarkable properties common to both—viz., the well-marked resemblance of the zoospores to some forms of the Infusoria, the amœboid-movement, and the existence of a plasmodium, which only becomes surrounded with a membrane at the epoch of reproduction. These minute parasites were observed by Pringsheim, and described by him in his work on *Achlya prolifera* as sexual organs of the *Saprolegnieæ;* but Cornu, in an exhaustive monograph on the subject, has shown their true nature. Among the reasons he assigns to justify this opinion are:—The analogy of the bodies with *Chytridineæ*, already known, and especially the identical form of the zoospores; the presence of undoubted sexual organs in the individuals attacked; and the changes, disturbances, and hypertrophies which can be observed in the affected plant. He proposes three divisions, or genera,—viz., one in which the sporangia are entirely free in the filament of the plant affected; a second, in which the sporangia are partially adherent to the filament; and the third, in which the sporangia are surrounded with a general membrane, which is itself adherent to the wall of the affected filament. The names he has given them are respectively *Olpidiopsis*, *Rozella*, and *Woronina*.

We come now to the economic portion of our subject, especially the relation that exists between *Saprolegnia* and the Salmon disease. The importance of the subject may be judged of from the account of the ravages of this disease brought to light by the enquiries of the Royal Commissioners. In the year 1850, a severe fungus epidemic broke out amongst the fish in the ponds of Ightham House, Kent, and the furred fish, as they were called, died in large numbers. In the spring of 1874, a still severer epidemic broke out in the same ponds, and was made the subject of investigation by Dr. Church, of St. Bartholomew's Hospital, who satisfied himself that the fungus affecting the fish was the *Saprolegniea*. The roach, dace, and gudgeon suffered the most; the small pike and perch were affected, but the large pike, perch, and the eels escaped. There is, however, very little doubt that the disease had existed in this country in a sporadic form for many years. So long ago as the spring of 1852, Dr. Crosbie, late surgeon to the *Challenger* expedition, investigated a case of the fungus disease in a salmon taken from the Tweed, and found that fishermen, and others conversant with the river, were fairly well acquainted with the fungus. But in the spring of 1877, the disease assumed an epidemic form in the rivers Esk and Nith; it soon spread to the Eden and adjoining rivers. In the spring of 1879, it was observed in the Tweed, where it rapidly became serious; and in 1880, when the Salmon Disease Commission was appointed, it had extended to the Nith, the Annan, the Esk, the Eden, the Cree, and the Dee, all flowing into the Solway Firth; to the Doon and the Ayr in Ayrshire; to the Derwent in Cumberland, the Lune in Lancashire, and to the Tweed. Since then the disease has broken out in the rivers of North Wales, and in the Tay and North Esk, in Scotland.

The first symptom of this disease is the appearance of small greyish or ashy discolourations of the skin, usually upon those parts of the body which are devoid of scales, such as the top and sides of the head, and the bases of the fins. When a patch of diseased skin has once appeared, it rapidly increases in size, and runs into any other patches which may have appeared in its neighbourhood. The marginal zone, constantly extending into the healthy surrounding skin, retains its previous characters, while the ashy central part changes. It assumes the consistency of wet paper, and can be detached in flakes, like a slough, from the skin which it covers. If the subjacent surface is now examined, it will be found that the epidermis, or scarf-skin, has disappeared, and that the surface of the derma, or true skin, is exposed. The affection, however, is not confined to the epidermis. As the patch acquires larger dimensions, the derma, or true skin, in its centre, becomes subject to a process of ulceration ; and thus a deep bleeding sore is formed, which eats down to the bones of the head, and sends off burrowing passages, or sinuses, from its margins. In severe cases the disease may extend far into the interior of the mouth, the edges of the fins become ragged, the gills are said to be attacked, and cases of the blinding of the fish, by extension of the disease over the eyes, are reported.

On advancing within the margin of the diseased area, hyphæ of the *Saprolegnia* are seen to penetrate horizontally between the cells of the epidermis, thrusting them asunder as the roots of an ordinary plant thrust themselves into the soil, thus giving rise to the radiating ridges, which here make their appearance. Proceeding further towards the centre of the diseased patch, the hyphæ become more numerous, and take a vertical as well as a horizontal direction. Of the vertical ones, some traverse the epidermis outwards, thrusting aside and disturbing its cells, and terminating in short free ends on the surface. Others of the vertical hyphæ are directed inwards, and, traversing the epidermis, pierce the superficial layer of the derma. Yet, nearer the centre, the epidermis is completely broken up into fragments, and detached cells are seen lying in the thick mycelium of the fungus, which now begins to develop zoosporangia. The hyphæ penetrate the derma, and ramify in the bundles of connective tissue; their ramifications usually end in curiously swollen extremities. Still more towards the centre of an ulcerated patch, the place of the epidermis is taken by the felted mycelium of the Saprolegnia, the superficial layer of the derma has disappeared, small vessels have often been laid open, and blood has been effused.

However extensive the disease may be, the flesh of the salmon presents little difference in texture, or in colour, from that of a healthy fish, and those who have made the experiment, declare that the flavour of a diseased fish is as good as that of a healthy one. No morbid appearances have been observed in the viscera. The death of the fish appears to be due, partly to irritation and consequent exhaustion, and partly to the drain on its resources, caused by the production of a large mass of vegetable matter at the expense of its tissues.

Several causes have been alleged for this disease. The first supposed cause was the pollution of the rivers; but this may be easily dismissed in faith of the evidence elicited before the Parliamentary Commission, that the disease is by no means confined to polluted rivers. Although, however, not a primary cause, it may have a most important secondary influence, and may determine, in fact, whether in any river, the disease shall be sporadic or epidemic.

That pollution is the primary cause of the appearance of another member of this group is shown by the following statement:—A factory for making spirit from turnips was established near Schweidnitz, in Silesia, and the refuse was poured into an affluent of the river Westritz, which runs by Schweidnitz. The result was such a prodigious growth of *Leptomitus*, that the fungus covered some 10,000 square feet at the bottom of the stream with a thick white layer, compared to sheep's fleeces; it choked up the pipes, and rendered the water of the town undrinkable. Of course, the universal *Bacteria* have been brought forward as the cause of the disease, having been found in large quantities on the diseased spots, upon which the fungus is supposed afterwards to locate itself. The *Bacteria*, however, are most probably only the result of a certain disintegration of the tissues by the mycelium of the *Saprolegnia*, and not the cause. A third view is that taken by Erasmus Wilson, who considers that the fungus is a morbid growth of the mucous produced by the skin of a diseased animal, and not a vegetable parasite, and that it closely resembles ringworm in the human subject, in which also there is a fungiform growth.

Cooke, in commenting upon this view, says :—" I should be most willing to believe with those who assert that the salmon-disease is a contagious disease, which spreads from fish to fish, producing blotches or eruptions, upon which a parasite afterwards establishes itself. It is certainly not an impossible cause, and none of the evidence really contradicts it, but I fear that is all which can be said in its favour. A single fish, with the skin and flesh diseased in the identical manner as in the ordinary disease, but from which the fungus was wholly absent, would suffice to prove that the fungus is not the cause of the disease. In the absence of this single evidence, I am afraid I must confess that, as far as we at present know, the fungus appears to be the active agent in the salmon-disease."

Huxley says :—" Close up to the free ends of the mycelium the epidermis is perfectly healthy, and this fact suffices to prove that the growth of the fungus is the cause of the morbid affection of the epidermis, and not its consequence. If it were otherwise, the structural alteration of the skin should precede the fungus, and not follow it, as it actually does.

It was at one time thought that the Salmon *Saprolegnia* could not live on anything but a salmon ; but Huxley has demonstrated that dead flies, and pieces of bladder, can be infected with the spores of the Salmon *Saprolegnia*, and will produce, in a short time, a fungus growth indistinguishable from the original plant, and he was able, by constantly infecting fresh material, to keep up a supply of the fungus from the end of December to the first week in April. From this study of its life-history, he was able to form the conclusion that the *Saprolegnia* of the salmon, like other *Saprolegnieæ*, is capable of living and flourishing on a variety of dead animal matters. De Bary, in his last researches, also infected meal-worms with the fungus. It seems probable that *Saprolegnia* is killed by salt water, so that the injured epidermis may heal when a diseased fish enters the sea. But as the mycelium ramifies in the derma, or true skin, where the sea-water cannot reach it, the disease may simply lie dormant till the return of the fish to fresh water.

There are certain predisposing causes which bear an important part in the propagation of this disease. One of these is injury to the skin of the fish, in the way of wounds, or bruises, received in fighting with one another, or in unsuccessful attempts to overcome obstacles in the passage up and down the river, whether weirs or dams. Again, while in fish in robust health a slight bruise would not result in parasitism, a debilitated fish would, in all probability, suffer. Instances of known debility, from retention of ova or spawning, make the bulk of fatal cases, and the few which are supposed to have been strong fish, may well be assumed to have been exhausted by overcoming obstacles in their way up the river, or otherwise to have been in a low and weak state. Shallow water is a source of debility to fish in general, through lack of food, and at this time fish congregate in the holes of the stream.

If we accept the theory that the resting-spores of *Saprolegnia*, which have previously been described, being heavier than water, sink to the bottom, they would consequently be washed into the holes, thus causing these hollows to become reservoirs for the zoospores which are liberated in the spring, and evident centres of contagion. When the water is high and plentiful, food is washed down from the land, the fish are well fed, do not collect in the holes, and are therefore not crowded together into the midst of contagion. At such times there is less disease; this is fully borne out by the evidence laid before the Commission.

We cannot, however, forget that the fish-fungus is no respecter of species or individuals. It attacks nearly all, if not all, fresh-water fish, and it exhibited its predilection for carp before the salmon-disease became prevalent. How is it that all the fish in the infected rivers are not destroyed as well as the salmon? The only answer possible is, that in some condition of bodily health or physical weakness, the salmon falls a prey, whilst the other fish, by a more robust constitution, or some peculiar circumstances which the salmon does not enjoy, escape with impunity. Some weight must be attached to the argument which has been advanced, that disturbing the natural conditions, by protecting the salmon, has tended to the production of a weaker and physically degenerated race. The coincidence should be borne in mind, that in all the great instances of devastating fungoid disease, there has been an undoubtedly weakened constitution in the subject, caused by over-cultivation and in-breeding, preliminary to the attacks. Such was the case with the silkworm, and it fell a prey to *Botrytis;* with the potato, and it succumbed to the *Peronospora;* with the vine, and it became a victim to *Oidium;* may we not add, also, with the salmon ere it was devastated by *Saprolegnia?*

We cannot deny that artificial arrangements for the control of nature inevitably fail. We make war upon small birds, and then exhibit surprise that the insects make war upon us, or upon our fields and orchards. We exterminate all the destroyers of sickly salmon, and then express surprise that we rear a sickly race. The argument was placed in a strong light when compared with the grouse disease by a writer in "Land and Water." He says:—"Take the case of the red grouse on our moors. The birds are protected by law for the greater part of the year, and their natural enemies, the various raptorial birds, are so assiduously hunted down as to have become, in some cases, practically extinct in this country; and the consequence of this destruction of their natural enemies has been, that all the weakly birds, which in natural circumstances would have been picked off by the larger hawks, have remained to breed and perpetuate a still weaker progeny. In a race of birds thus weakened, the parasite found everything to favour its propagation, and the grouse disease became an epidemic; and many proprietors, recognising this, are now protecting the peregrine falcons as strictly as they preserve the grouse.

"Something very similar has taken place with the salmon. The otter is the natural enemy of the salmon in the fresh waters, but they have been hunted, trapped, and shot, till not one remains, where formerly there were dozens. The otter, like the peregrine, takes the prey most easily captured, thus removing the weakly, the sick, and in fact all those which, from whatever cause, would give rise to a degeneration of breed, If there had been otters in the district, in the numbers in which they once were, those wretched-looking salmon now so frequently seen along the sides of the Nith, would all have been dragged out and eaten by them. I am confident the disease would be checked, if the otters, just for a change, were protected for a year or two. The course of the salmon-disease and the grouse-disease tells us, in unmistakeable language, to beware of altering the balance of nature. Left to herself, the great law of the 'survival of the fittest,' would always keep nature's numerous family in a prosperous and healthy condition." We might enquire which has destroyed the largest per-centage of fish—the otter or the disease? Which left the survivors in the best condition to fight the battle of life in the succeeding seasons? Probably, few would hesitate to welcome back the otters, if they could be assured that thereby the disease would be controlled. Yet we may rest assured that it is quite hopeless to think of killing off the fungus. We have not killed the potato-disease, and have no prospect of doing so. If success is to be achieved, it must be, by restoring to the salmon such a constitution as will enable it to defy the attacks of its parasites.

I have dwelt at length on the genus *Saprolegnia*, as being the representative genus of the family; but there is strong reason to suppose that *Achlya* has, also, a large share in the work of destruction which we have been considering, and *Leptomitus* has also been found parasitic on fresh-water fishes; the other genera seem to flourish principally on dead organic remains, whether animal or vegetable.

The following is the list of works referred to in the above paper:—Grevillea, Vols. 1, 6, and 9; Annales des Sciences Naturelles, Vol. 15; Quart. Journ. Micro. Sci. for 1867, 1882, and 1883; Ray Society's Proceedings for 1845 and 1853; Commissioners' Report on the Salmon-Disease (*Eyre and Spottiswoode*); Berkeley's Cryptogamic Botany and British Fungology; Micrographic Dictionary; Science Gossip for 1865; Cooke's Handbook of Fungi; and Fungi (*International Scientific Series*); The Microscope, Carpenter.

EXPLANATION OF PLATES XXXVII. and XXXVIII.

Plate XXXVII.

Fig. 1.—*Achlya: a*, Oogonium; *b*, Antheridium.
2.—*a*, Oospheres; *b*, Antheridium; *c*, Tubes of Antheridium.
3.—Oogonium containing protoplasm, with vacuoles.
4.—*a*, Oospheres; *b*, Antheridium; *c*, Tubes of Antheridium.
5—7.—Formation of Oospheres from toplasm.
8.—Antheridia (*a*) emptying themselves into (*b*) the Oospheres.
9.—Oogonium, with single Oospore and Antheridium.
10.—*a*, Oospores; *b*, Antheridia.
11.—Two sporangia of *Achlya: A*, one still closed; *B*, with the zoospores escaping; *a*, zoospores just escaped and still in a state of rest; *c*, after commencing to swarm, having abandoned their cell-walls (*b*).
12.—Oogonia and Antheridia of *Achlya*. Course of development indicated by letters, *A—E: a*, Antheridium; *b*, its tube, penetrating into the Oogonium.

Plate XXXVIII.

1.—Head of Smelt affected with *Saprolegnia*.
2.—Scale of Salmon, with fungus *in situ*.
3.—*Monoblepharis;* general figure of plant.
4.—Oogonium in process of formation.
5.—*a*, Oogonium; *b*, Papilla; *c*, Antheridium.
6.—*a*, Oogonium; *b*, Papilla burst open; *c*, Antheridium.
7.—Antherozoids escaping and attaching to Oogonium.
8.—Fecundated Oosphere, empty Antheridium.

Parasites of *Saprolegnia*.

9.—Filament of Saprolegnia containing spores of *Olpidiopsis*.
10.—The same at a later stage and enlarged, showing absorption of protoplasm by the parasite.
11.—Filament, showing spores of *Olpidiopsis*, in different stages of growth: *a*, Emitting zoospores; *b*, Adult sporangium; *c*, containing vacuoles; *d*, more advanced spores.

On Fixing the Aniline Dyes.

THE *British Medical Journal* for March 10, contains an article by Mr. H. A. Reeves, F.R.C.S.E., on fixing the aniline dyes in microscopical staining; and though in the article mention is only made of anatomical and pathological preparations, we think it likely that the method described will be found capable of a much wider application. Mr. Reeves states, that for the last eighteen months he has been systematically experimenting with a vast number of chemicals, singly, and combined in various proportions, with a view to finding a suitable mordant, and the result has satisfied him that the dyes may be fixed by placing the stained sections first, for from three to five minutes in a mixture of equal parts of a saturated aqueous solution of tannin, to which a little carbolic acid has been added, and distilled water. Then wash in water, and transfer for the same length of time to a mixture of tartar emetic and water, a few drops of a saturated solution of tartar emetic being added to a watch-glass full of water. The sections should then be again washed; placed for five or ten minutes in strong methylated spirit, drained of superfluous spirit, and mounted in Canada Balsam or Dammar, after having been passed through oil of cajuput, cloves, juniper, aniseed, or turpentine. The tannin and antimony solutions should be filtered into the watch-glass before using, as also the dyes. Preparations hardened in Müller's fluid or spirit answer best, but chromic acid hardened specimens can be used, if, previously to staining, they be soaked for twenty or thirty minutes in methylated spirit.

Other agents will partially or completely fix some of the anilines; such as arsenious, acetic, hydrochloric, and carbolic acids, hypophosite of soda, stannate of soda, and silicate of soda, to which a little hydrochloric acid has been added, and these should be tried in special cases. A saturated aqueous solution of acetate of potash fixes roseine, saffranine, and soluble blue, and partly fixes fuchsin.

Mr. Reeves also draws attention to two or three new or little-known dyes, which he thinks might be used with advantage in microscopy. The new dyes are Phloxine and Erythrosine. They stain rapidly and deeply in weak aqueous solutions, and stand spirit well. Connective substances and the protoplasm of cells are, in rapid staining, preferred by them to the nuclei, which, however, stand out on the stained ground very clearly. Phloxine is the more beautiful and pleasant colour to work with. Both are soluble in water or spirit, and weak solutions stain quickly. If sections are placed in weak solutions for several hours, the nuclei often take on the stain. Both these anilines are darkish red powders by reflected light, Phloxine having a faint purple-crimson colour, and the colour of the solutions in a test tube will vary with the strength. Murexide is a brownish-red powder, very slightly soluble in cold water, not soluble in spirit, but readily so in boiling water. On cooling and filtering, sections are immersed for five or ten minutes, when it will be found to give a good ground-stain for double-dyeing. With acetate of zinc it gives a yellow stain.

Maroon, phosphine, cerise, and mauve are all useful and unused colours, phosphine yielding a good ground-stain of a rich golden yellow, available with advantage for double-staining. The rest resemble most of the other anilines in picking out the nuclei, but they also stain the other structures. Dilute aqueous or alcoholic solutions stain rapidly, and may be fixed by the process described above, though phosphine holds very well of itself.

Induline, which is also a new aniline colour, is a dark powder, giving a pale bluish-purple stain. If used after carmine or picro-carmine, the cell-body and intercellular substance will be preferred by the induline, and the nuclei and connective fibres by the other colours. It dissolves in warm water or dilute alcohol. Maroon, phosphine, and cerise are new to histology.

Any of the dyes mentioned by Mr. Reeves may be obtained in small quantities from Mr. Cooper, chemist, Oxford Street, London, W.

The Application of Photography to the Delineation of Microscopic Objects.

By William Pumphrey.

A Paper read before the Members of the Bath Microscopical Society.

THE subject of the present paper may, perhaps, be thought hardly fit to engage the attention of the microscopist, seeing that it can never supplant the study of natural objects by the eye of the observer through the microscope. Photo-micrography can never become a means of exact scientific research, but must be reserved for the more popular display of microscopic objects, or as a help towards their more accurate delineation. The difficulty of obtaining really good and reliable drawings of such objects must make any easily available plan for giving us such copies a *desideratum*, and if such a plan does not at once give us all that we desire, it is a fault belonging alike to other things, even to those which are capable of the utmost advance towards perfection.

The application of Photography to the delineation of microscopic objects is, at the present day, very far from being a novelty. So far as I am aware, the earliest photo-micrographs were produced about the year 1851, on silver plates, prepared after the process of Daguerre, and those who know anything of the difficulties attending that process would be surprised that any really valuable results could have been obtained by it. The introduction of a film of collodion, as a vehicle for exhibiting the haloid salts of silver to the action of light, greatly facilitated the production of good photo-micrographs. This photographic process had, however, one great disadvantage, viz.—the sensitive surface was a moist one, and as, in consequence of the great dispersion of the light, a very long exposure was often required to obtain a sufficiently vigorous impression, the surface of the prepared plate became dry during the exposure, and the result was that the luminous impression was unequal in different parts of the plate, and the picture being uneven was rendered comparatively valueless.

But, lately, we have had placed in our hands a medium that is free from this serious defect; a medium which, while it obtains for us a much more sensitive surface, enables us to give any amount of exposure, without the least inconvenience. Another great advantage we now possess is that microscopic lenses are better corrected, and the luminous and actinic foci are now brought much more into unison than in those lenses made twenty or thirty years ago.

The subject resolves itself into four sections :—

The first relates to the preparation of the sensitive surface.

The second to the mechanical contrivances for placing this sensitive surface in a position to receive the luminous image.

The third, to the optical means of producing this image; and

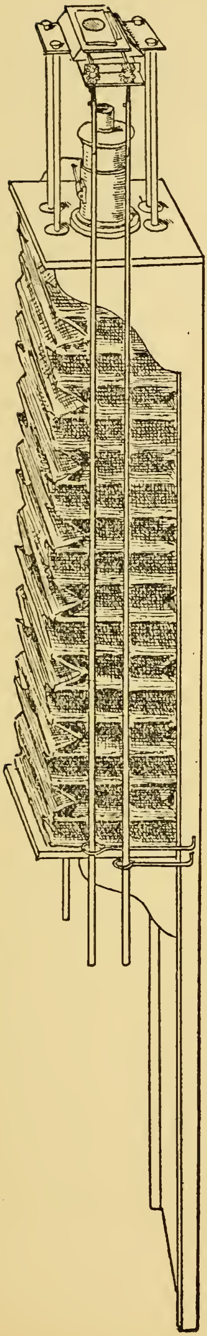
The fourth, to the chemical processes connected with the development of the latent image.

It will not be needful to say more than a few words on each of these sections.

First, as regards the sensitive surface. This is formed of an emulsion of Bromide of Silver, in gelatine, which is spread on the surface of a plate of glass as evenly as possible, and allowed to dry quietly, being, at the same time, carefully protected from dust and light. Owing to the exceeding sensitiveness of the Silver Bromide to light, very great care must be taken to prevent the access of any light except such as has no actinic properties. The process of preparing these plates is so difficult, and the causes of failure so numerous, that it will seldom be worth the while of any person to make them for himself, especially as they are now sold of standard quality, and at very moderate prices, by several firms. It may appear invidious to name any special maker, but those which I have used, and intend to use in illustration of this paper, are made by Swans, of Newcastle.

Second, the camera to be used for Photo-micrography differs only from the ordinary camera in being capable of much greater extension in length. In reality we are going through a directly reverse operation to that of the ordinary photograph. There we have a large object and a greatly reduced image; here we have a minute object and a greatly enlarged picture. The form of

Fig. 24.



camera (see Fig. 24) that I have found most convenient has the front which carries the lens, etc., and the back which carries the prepared plate, connected by a light-proof, bellows-like body, which permits the back to slide to and fro on a rigid base-board, about 4 feet 6 inches long. With this, any position between one of 6 inches and 54 inches from the lens can be readily obtained, and when obtained may be permanently secured by a set-screw. In the front of the camera is an arrangement for carrying the lens and the object; the object is fixed on the mechanical stage, and the image is formed on the ground glass by moving the lens by means of a rack and pinion, until the best possible focus has been obtained. And as, when the focus had to be ascertained, at so great a distance as 4 feet 6 inches, it would be manifestly impracticable to manipulate this rack and pinion, they are actuated by a pair of small bevelled wheels, the axis of one of the wheels extending into a long handle that lies along the side of the camera, and is thus always within reach of the operator. The sensitive plate is contained in an ordinary dark-slide.

Third, as regards the lenses, my own experience has been, that the lenses as at present constructed give the visual and actinic foci coincident; but, no doubt, many good lenses require correction; and this can be done, either by putting the objective out from the object, or by bringing the dark-slide nearer to it. If this correction is needed, its extent can only be found by experiment, and it will be attained more easily by moving the dark-slide rather than the lens. An exceedingly minute alteration of the latter makes a very great difference; for, in using a long focal distance, as above arranged, a large change in the position of the sensitive plate—say, two or three inches—will have the same result as an extremely minute one in that of the lens;

and it is, of course, much more accurate, as well as safer, to obtain the desired effect by a large change than by a very minute one.

The time of exposure will depend on a great variety of conditions :—the character of the light used, the density of the object, and the amount of amplification. For instance, supposing we are using a four-inch lens at a certain distance, it may take *fifteen seconds* to obtain a satisfactory impression, but if we used a one-eighth on the same object and at the same distance, it, in all probability, would require *forty minutes.*

The light which I have found most convenient is that of a duplex paraffin oil lamp, but sun light, diffused day light, the lime light, or the magnesium light, may be used.

And, lastly, we have to consider the chemical operation for developing the image. The active agent in this process is Pyrogallic acid in presence of Ammonia; but experience shows that its effect is greatly increased by employing in combination with it other re-agents, whose action is of a restraining character.

The formulæ I use are :—

A.—Pyrogallic Acid ...	1 oz.	Citric Acid ...	60 grs.
Sulphate of Soda.	2 oz.	Water	8 oz.

For use mix 1 part A. to 15 parts water.

B.—Liq. Am. Fortiss. ·880,	1 oz.	Sulphate Soda ...	2 oz.
Bromide Ammon...	$\frac{1}{2}$ oz.	Water	8 oz.

For use mix 1 part B. to 15 parts water.

For a $\frac{1}{4}$ plate ($3\frac{1}{4}$ by $4\frac{1}{4}$) take about 5 or 6 drs. of the dilute B. solution, and float it evenly over the surface of the plate, laid on its back in a shallow tray. Remove all air-bubbles from the surface with the finger or a soft brush, and when the surface is fully wetted, add an equal quantity of the dilute solution A. If the time of exposure has been sufficient, the image will begin to make its appearance in about two minutes; but the full development may take from ten minutes to a quarter of an hour. The process may be continued so long as the parts of the plates that have been protected from the action of the light remain clear. It is better to carry on the action too long than to arrest it too early; the impression loses a good deal of force in the after-process of fixing and hardening. After the image is fully developed, the plate is placed in a saturated solution of Hyposulphite of Soda, or a dilute solution of Cyanide of Potassium, either of which will dissolve out the silver salt which has not been acted on, and leave the picture clear and transparent in those parts which are ultimately to represent the dark parts of the object. When taken from the Hypo. solution, the plate should be placed in a strong solution of common Alum. This partially tans the Gelatine, renders it quite insoluble, and prevents any tendency to leave the glass. After being well washed to remove the fixing and hardening salts, the plate may be dried, either by the fire, or by spontaneous evaporation, and is then fit to produce a positive picture either on glass as a lantern transparency, or on paper as an ordinary photograph.

The positive picture may be obtained in two ways: either by setting up the negative, and obtaining, by transmitted light, a positive image in the camera, then dealing with this image as with the original negative, going through the same processes of development and fixation; or by placing a second dry plate in close contact under the negative, and allowing the light of an ordinary gas-burner to fall on it for about 5 seconds, after which it can be developed, etc., as usual. The time of exposure will depend on the intensity of the source of light, on the distance from the source of light, and on the density or transparency of the negative; but with an ordinary tulip burner, at a distance of about five feet, and with a fairly clear negative, five seconds will be found sufficient.

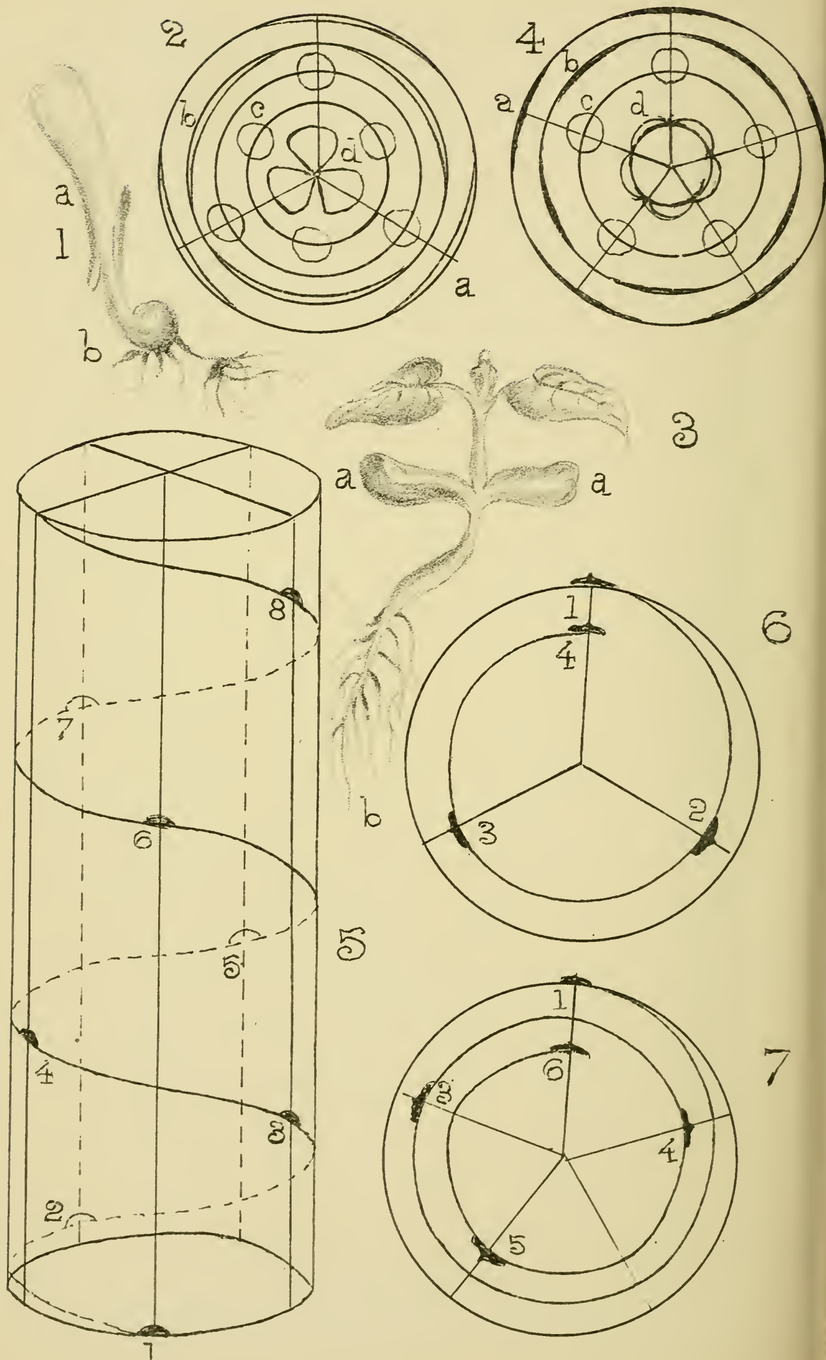
If it be desired to produce a positive on paper, this can be best done by using some of the papers which are now sold ready sensitised, and which will keep, if protected from light, for an indefinite period. This paper is exposed to ordinary day light under the negative, and examined from time to time to note the progress of the action of the light. When sufficiently dark, the paper is removed, and placed in a solution of Hypo. Soda, which leaves the print of a disagreeable red tint; it is afterwards toned down in a solution containing Gold Chloride, and when the desired tint is obtained, should be well washed to remove all traces of the salts, and dried either by the fire or by quiet evaporation.

But now comes the question, What is the process really worth? How far is it available? and What circumstances limit its application, and detract from its usefulness?

As I said in the first few sentences of my paper, I do not consider that Photo-micrography can supersede the study of natural objects by the microscope. The eye of the observer is a far more potent instrument of research than any artificial contrivance can possibly be. But there are other difficulties. Unless the object to be delineated lies very nearly in one plane, the different parts cannot be in focus at the same time, and confusion is produced. Again, different colours have very different effects on the sensitive plate, and as the photographic image is produced only in light and shade, the charm of colour is wanting. And again, there are objects rendered visible to the eye by the microscope, which are of such extreme tenuity that they will not form an optical image of sufficient force to produce a satisfactory photograph. All these things limit the range of the process, and detract from its value as a really scientific means of research; but as an assistance in the reproduction of microscopic objects, either for the draughtsman or the engraver, it is of great value, and for popular demonstration there can be no better means employed than the display on the screen of magnified images of objects, previously obtained direct from such objects in the camera.

Such appears to be the position of Photo-microscopy at the present time. The process has been greatly simplified, and though all that the man of science needs has not yet been attained, it may in the future help us to reach all that is required.

[This paper was illustrated at its close by the practical working of the system described. With the camera, a drawing of which we annex, several photographs of microscopic objects were taken in a most perfect manner, and we were much impressed with the exceeding effectiveness and simplicity of the process.—Ed.]


1
2
3
4
5
6
7
a
b
c
d

Withered Leaves.

By J. W. Fisher.

Plate 39.

THE botanical definition of a leaf is "a thin flattened expansion of epidermis, containing between its two layers vascular and cellular tissue, nerves, and veins, and performing the functions of exhalation and respiration." The elementary organs of which all vegetable structures are composed, are simple cells, placed in juxtaposition or superposition. These cells assume many different forms according to the position they are to occupy, and their contents are almost as varied as their shapes, adapting them for the purpose they are intended to serve in the vegetable economy. We might trace the cell from its most simple form in some of the microscopic fungi, through all its different modifications into the most highly organised vegetable structures, did time permit. Let it suffice, however, to point out that the outer or epidermal coverings of the leaves of trees, with which we are now more particularly concerned, are, under the microscope, found to consist of cells, placed more or less closely together, or in juxtaposition, forming a flattened expansion, and containing between them the vascular and cellular substance of the leaf.

If we compare a leaf to an animal, the epidermis will represent the skin, the ribs and veins branching off from the mid-rib will be the bony skeleton, and the inner substance, with its varied cell contents, will stand for the flesh and internal organs. A closer examination of the epidermis will show the presence of numerous crevices or pores between the cells, formed by two or four guard-cells, which are crescent-shaped, and smaller than the epidermal cells, affording a means of communication between the outer atmosphere and the inner substance of the leaf. These pores or stomata appear to perform the twofold functions of respiration and the transmission of fluids. The cellular mass intervening between the two layers of epidermis consists of loosely packed cells containing chlorophyll, the colouring matter of the leaves, which is visible through the transparent cells of the epidermis. In addition to the chlorophyll, there are many other substances both fluid and solid. Among these may be enumerated starch, sugar, oil, tannic acid, crystalline formations, and albuminoid or proteinaceous compounds. The starch granules, and raphides or plant crystals, form exceedingly interesting and beautiful objects under the microscope. The internal mass, or diachyma, of the leaf is also traversed by the midrib and branching veins, which are composed of fibro-vascular tissue, serving the various purposes of imparting strength and durability of form to the leaf, and of the transmission of sap from the root through the branches, and its retransmission downwards after the various chemical changes have taken place in the leaf, thus fitting it for the further development of the vegetable structure. These changes are partly effected by the action of the atmospheric air, which is brought into contact with the cell contents, by the presence in the diachyma of numerous cavities between the cells, and communicates with the outer air by means of the stomata in the epidermis. The number of these pores or stomata varies greatly in different leaves, from a dozen or two up to 160,000 on a square inch. The leaf of the Lilac has been found to contain 708,750; while the Lime tree has 1,053,000 on each entire leaf. The important part which the stomata are intended to fulfil in the vegetable economy may be manifest, if we glance at the methods by which the life of the plant is sustained.

We have already stated that the leaf is composed of various cells, and have enumerated some of the substances contained within them, but it must be remembered that the essential constituent of all living cells is protoplasm, a mucilaginous, semi-fluid, transparent, hyaline substance, which, at some period of its existence, secretes out of itself an enveloping membrane, more or less solid and elastic, which is known as the cell-wall; and the process which we term "growth," consists in the formation of new cells, and the production of new chemical combinations; and these manifestations of the mysterious power denominated "life," can only take place by the agency of these cells containing protoplasm. Cells in which the living protoplasm has become changed into lifeless organic substances, serve a useful purpose in the plant as protecting or formative envelopes, by their form, hardness, or power of attracting water. The nutrient substances which are essential to the life and growth of vegetable cells are, first, those which enter into the composition of protoplasm; and these are carbon, oxygen, nitrogen, hydrogen, and sulphur, and in addition to these essential elements may be enumerated iron, calcium, potassium, magnesium, phosphorus, sodium, and chlorine. These various nutrient substances are taken up, (in the higher orders of plants,) partly by the roots from the soil in the form of vapour, and partly by the leaves through the agency of the stomata, in the gaseous condition from the atmosphere; for it is only in one or other of these conditions that they can reach and become the nutriment of the protoplasm, through the substance of the cell-walls, and this is effected by the action of osmose, which is simply the mixing of two fluids of different densities, separated by a permeable membrane such as is found in the cell-wall. The aqueous particles absorbed from the soil by the roots are carried upwards through the fibro-vascular bundles to the leaves, where the surplus quantity not required in the vegetative process is exhaled into the atmosphere by transpiration, while the remainder becomes acted upon by the gases passing through the stomata.

The atmosphere is composed principally of oxygen, nitrogen, and carbon in the form of carbon-dioxyde or carbonic acid gas. These are absorbed, the carbon and nitrogen are retained, and a portion of the oxygen is exhaled, after having effected certain chemical changes in the constitution of the fluid sap, and thus fitted for its downward course, building up and solidifying the various tissues, and perpetuating the life of the plant. These changes in the condition of the sap are marked by an alteration in the colour of the chlorophyll, which gradually loses its green hue, and takes on the various shades of yellows, browns, and reds, which clothe with such a charm the autumnal foliage of vegetation; and the fibro-vascular bundles having served their purpose, and being no longer needed for the transmission of fluids, become constricted in the petiole, at the point of its insertion into the stem, until the now withered leaf falls to the ground, to recommence, by its decomposition, the wondrous cycle of vegetation life.

Hitherto, our examination of withered leaves has been chiefly by the aid of the revelations of the microscope; but much may be learned by their megascopic examination, or so much as may be ascertained by the unaided eye, and to this we shall now address ourselves. Taking up from the ground a few withered leaves fallen from different trees, we shall perceive that all are not alike, either in size, shape, or arrangement. In some, the petiole or leaf stalk is long, in others short. The general shape and outline of the leaves differ, and the arrangement of the ribs and veins are as various as the leaves themselves. All these variations are indications, and miniature representations, of the trees on which they grew. Thus the length of the petiole will indicate the comparative height which the stem or trunk attains before it becomes divergent in the branches; and the venation will show the general arrangement and angle of divergence of those branches, and their sub-division into smaller branches, stems, and twigs. And these, again, have their correspondence in the direction and ramifications of the roots. It would be interesting to stand for a few minutes before some tree—say an oak, a beech, or an elm,—and, leaf in hand, compare the course and ramifications of its ribs, and veins, with the now leafless branches standing out in bold relief against the grey wintry sky, and notice the strong resemblance which exists between them.

Not only do these reticulated veined leaves show us the general outline of the trees on which they grew, but they are one of the marks by which we learn that these trees are individuals in the great family of Dicotyledons or exogenous plants, as distinguished from the endogens or Monocotyledons; and so take us back to the earliest period of their independent existence. Thus we are taught, that when the seed was cast into the ground, it germinated, and thrust a fibrous rootlet downwards, while from the yielding soil there appeared two or more green, fleshy, leaf-like opposite cotyledons. And then as growth proceeded, there rose a stem, which subsequently became a trunk consisting of both cellular and vascular tissue, a portion of the latter being elastic vessels, and comprising three parts, one within the other, viz., bark, wood, and pith, and increasing by an annual deposit of new wood and cortical substance between the wood and the bark; hence we may compute the age of an exogenous tree, by counting the number of annular rings discovered in a transverse section of its trunk. Further, we gather that the flowers possess a symmetrical arrangement of four or five parts, or their multiples. For instance, the flower of the apple-tree has a five-toothed calyx, five petals, numerous stamens, styles one to five, and ovaries one to five, developing into one to five seeds in the fleshy pome, which is generally spoken of as the fruit of the apple. On the other hand, the embryo of the monocotyledon has but one seed-lobe or cotyledon (or, if two, then the accessory one is imperfect and alternate with the other, not opposite as in the other class); the trunk is composed of cellular tissue, among which the vascular tissue is mixed in close bundles, without any distinction of pith, wood, and bark; the leaves are parallel veined; and the several parts of the flowers are arranged in threes or their multiples. A familiar instance of an endogenous stem may be seen in a piece of common cane, cut across in transverse section.

Plate 39, Figure 1, shows the single cotyledon in a germinating grain of Indian Corn. Figure 2 is a diagram of the arrangement of floral parts in a monocotyledonous plant, in which the three sepals of the calyx, and the three petals of the corolla alternate with each other. In this example there are six stamens (a multiple of three), disposed in two whorls of three each, also alternating with each other, and with the three pistils.

Figure 3 exhibits the mode of germination of a bean (Dicotyledon), with its two cotyledons opposite to each other, and above these, two of the true leaves, and the growing bud at the apex of the stem. Figure 4 is a diagrammatic representation of the flower of a Dicotyledon, in which all the parts are in fives, or quinary arrangement.

Perhaps among the withered leaves at our feet may be found a piece of the stem which has been broken off by some strong gust of wind. Let us take it up and examine it. We shall find from the scars of the severed petioles, that the leaves were inserted in what at first sight may appear an irregular and accidental manner, but further observation will reveal a beautiful law and order in their arrangement, and this is technically known as the phyllotaxis of plants, which simply means the relative positions of leaves on the axis. If the broken piece of branch in our hand is from the oak, the poplar, or the apple, we will fasten one end of a thread to the stalk of a leaf near the bottom of the stem, then carry it to the next leaf above, and so from leaf to leaf, until we arrive at one situated perpendicularly above the first leaf; and we shall find that the thread has made two complete circuits of the stem, and has embraced five leaves in its cycle, the last leaf being the sixth in order from the first.

This arrangement of leaves is represented by the fraction 2-5ths, where the numerator denotes the number of spirals, and the denominator the number of leaves, in the cycle. A diagrammatic representation of such a stem will show five perpendicular lines, upon which the leaves are placed in alternate order. Thus, starting with the first line in the centre, and passing around the series from right to left, we shall find the first leaf on the first perpendicular, the second on the third, the third on the fifth, the fourth on the second, the fifth on the fourth, and the sixth again on the first line—making two entire circuits to include the five leaves.

This will be rendered more intelligible from an examination of the diagram in Figure 5, which shows the leaves arranged in perpendicular lines around the stem. The same series—2-5ths—is also shown in transverse section in Figure 7; and the 1-3rd arrangement in Figure 6.

The most simple order is that in which the leaves are situated on opposite sides of the stem as in the lime and elm, where a single spiral includes two leaves; and this is denoted by the fraction $\frac{1}{2}$. In the next form, three leaves are contained in a single spiral, of which the birch is an example, and this is expressed by the fraction $\frac{1}{3}$. We have now obtained three fractions, which may be continued in regular sequence; the sum of the two preceding numerators forming the numerator of the next fraction, and the sum of the two denominators being the next denominator. This is termed the primary series, and the order will be as follows:

$$\frac{1}{2} \quad \frac{1}{3} \quad \frac{2}{5} \quad \frac{3}{8} \quad \frac{5}{13} \quad \frac{8}{21} \quad \frac{13}{34} \quad \frac{21}{55} \text{ etc.}$$

In some of the more complex arrangements there may be two or more spirals, the directions of which may be from right to left, or dextral; or from left to right, or sinistral; giving rise to a secondary and tertiary series of fractions, in each of which the same law is followed, in the production of the numerators and denominators, as in the primary series. The secondary series occur in the following order:—

$$\frac{1}{3} \quad \frac{1}{4} \quad \frac{2}{7} \quad \frac{3}{11} \quad \frac{5}{18} \quad \frac{8}{29} \text{ etc.}$$

And the tertiary series will be:—

$$\frac{1}{4} \quad \frac{1}{5} \quad \frac{2}{9} \quad \frac{3}{14} \quad \frac{5}{23} \quad \frac{8}{37} \text{ etc.}$$

These fractions not only denote the number of revolutions and leaves in each cycle, but also indicate the angular divergence of the perpendicular series of leaves. As there are 360 degrees in a circle, the fraction $\frac{1}{2}$ will represent an angle of 180 degrees; $\frac{1}{3}$ will equal 120 degrees (Figure 6); while 2-5ths gives 144 degrees of divergence, or 2-5ths of a circle, as shown in Figure 7, which is a transverse projection of the diagram in Figure 5. The limits of our paper will not permit us to proceed further on the subject of Phyllotaxis, and so contenting ourselves with this very brief reference to a deeply interesting study, we once more take a glance at the withered leaves before us, and inquire if they have anything more to teach us before closing.

We have already referred to the change of colour, as being partly due to chemical and physiological action in the chlorophyll and cell structure of the leaf, in the processes of growth; but may we suggest that some portion at least is caused by the influence of light on the fluid sap? It is well known that plants grown in darkness become etiolated or blanched, and that living vegetation turns instinctively to the light, but, perhaps, we may go a step farther, and trace the formation of autumn tints to the same subtle power, which thus becomes both a cause and an effect. Light may be analysed by the aid of a prism, and is then seen to be composed of seven colours, familiar to us all in the rainbow and in the prismatic spectrum, viz., red, orange, yellow, green, blue, indigo, and violet. Of these, the red, yellow, and blue, are known as primary colours, since by the admixture of these in certain proportions the secondary tints are produced. Thus orange is a combination of red and yellow; green, of yellow and blue; and violet, of blue or indigo and red. Again, from these secondary colours, are derived the tertiary, citrine (orange and green), olive (green and violet), and russet (violet and orange), and by further combinations every shade and tint may be obtained.

The several parts of the spectrum also possess different physical properties. Thus the yellow are lighting rays; the red, heating; and the violet, actinic or chemical; the two latter being continued for some distance beyond the visible red and violet boundaries of the spectrum.

Every object we see is rendered visible to us by the reflection of certain portions of the spectrum, and gives us the impression of colour or hue, from the rays of light so reflected.

Let us apply these principles to the leaves we are now examining. In the spring time we saw them of a bright and clear green, reflecting almost pure yellow and blue, and absorbing the heating red, and actinic violet rays; and, like children at play, they clapped their glad hands and made sweet music with the rustle of their boughs in the passing breeze, as if in the very exuberance of their youthful life. As summer advanced they became darker in hue, reflecting more of the indigo and orange, and still absorbing heat and actinism. During this time the ascending sap was being acted upon by mysterious influences, preparing and perfecting it for its future work in conserving and perpetuating the life of the tree,—and it may be, that the absorbed heat and actinism of the solar rays have an important part in these chemical and physiological changes. But in the later autumn the process is completed, the active work of the leaves is done, and the heat rays, and the actinic rays, being no longer required, are now also reflected, producing those varied tertiary colours which make the withered leaves so strangely beautiful; as if Nature, in approbation of the good work done, would crown each tree with diadems of gold, ere they cast them at the feet of the great Ice King.

But though thus withered, dead, and fallen to the ground, the great mission of the leaves is not yet completed. In another sphere and under other modifications, they have yet further work to do. The withered leaves of countless ages back, hidden away in darksome chambers, come forth again, and in a thousand ways minister to our wants to-day. They are about us, and touch us on every side. Cut, carved, and polished by the hand of the artificer, they become articles of beauty for our personal adornment. Dug and quarried by brawny arms, they afford us the light by which we read this paper, and the fire by which the apartment is warmed. They help to propel us in our travels by land and sea, and set in motion a myriad wheels to supply the unnumbered wants of civilised life. Transformed by the skill of the chemist, they supply some of our sweetest perfumes and richest dyes. They are all around us like some vast circle, within whose almost boundless circumference we may describe the smaller circles of our daily needs; and the central point of all these wonders is but a withered leaf!

Our tale is told, but ere we close, permit one word of moral teaching conveyed in two brief extracts. The first is from the pen of a modern anonymous writer, slightly altered to suit our title:—

Oh withered leaves! through branches bare,
I see the sky broad stretching, where
Ye bounded once our vision.
Ah me! until grim age destroy
The glamour of uncertain joy,
We think the world Elysian.

Yet wherefore should we sigh to know,
The charm of May, the summer glow,
Too transiently are given?
Earth's beauty haply is but gone,
That we may learn to rest upon
The sweeter hope of heaven.

Thrice happy he who thus receives,
A lesson from the withered leaves,
While Nature round him sorrows.
Who meets with mind attuned to praise
Reflection born of darkening days,
And so contentment borrows.

Our second extract is from a higher, because inspired source, and bears upon it the imprimatur of the Divine Architect, who gave to the world of Nature its wondrous being, and who by these withered leaves says to us—" The grass withereth, the flower fadeth, but the Word of our God shall stand for ever."

EXPLANATION OF PLATE XXXIX.

MONOCOTYLEDON.

Fig. 1.—Germination of Indian Corn :—*a*, single Cotyledon ; *b*, Rootlets.

,, 2.—Diagram of Ternary Flower of Tulip :—*a*, Sepals ; *b*, Petals ; *c*, Stamens ; *d*, Pistils.

DICOTYLEDON.

,, 3.—Germination of Bean :—*a.a*, Cotyledons ; *b*, Rootlets.

,, 4.—Diagram of a Quinary Flower of Crassula :—*a*, Sepals ; *b*, Petals ; *c*, Stamens ; *d*, Carpels.

PHYLLOTAXIS.

,, 5.—Two-fifth arrangement of Oak Apple, Poplar, etc.

,, 6 and 7.—Transverse projections of Stems, showing Phyllotaxial arrangement of leaves and angular divergence. Fig. 6, one-third=120° ; Fig. 7, two-fifths=144°.

Methods of Microscopical Research in the Zoological Station in Naples.

BY C. O. WHITMAN.

From " The American Naturalist."

SECOND PAPER.

(Continued from page 108.)

II.—STAINING METHODS.

IT has gradually become a settled custom in the Zoological Station, to mount microscopical preparations in balsam wherever this can be successfully done ; and to avoid, as much as possible, the use of aqueous media, both in mounting and staining. The disadvantages often arising from the use of these media in staining alcoholic preparations, such as the tearing asunder of fragile tissues caused by the violent osmosis; swelling, the effects of which cannot always be fully obliterated by again transferring to alcohol, and maceration, which is liable to result where objects are left for a considerable time in the staining liquid, may all be avoided by using alcoholic solutions. Objects once successfully hardened may be left in such solutions for any required time, and when sufficiently stained, be washed in alcohol of a corresponding strength, and then passed through the higher grades without being exposed to water from first to last. As a rule, alcoholic dyes work quickly, and give far more satisfactory results than can be obtained with other media. They penetrate objects more readily, and thus give a more uniform colouring where objects are immersed *in toto*. Even chitinous envelopes are seldom able to prevent the action of these fluids.

It is not, however, to be denied that non-alcoholic dyes may often do excellent work, and in certain cases, even better than can be otherwise obtained. In the case of the *Turbellaria*, Dr. Lang has found picro-carmine to be one of the best staining agents, and this has been my experience with *Dicyemidæ*. As Dr. Mayer has remarked, the swelling caused by aqueous staining fluids is not always an evil, but precisely what is required by some objects after particular methods of treatment.

From experiments recently made, Dr. Mayer has found that dyes containing a high percentage of alcohol, stain more diffusely than those of weaker grades, from which he infers that strong alcohol robs, to a certain extent, the tissues of their selective power, and renders them more or less equally receptive of colouring matter.

1. **Kleinenberg's Hæmatoxylin.***—1. To a saturated solution of chloride of calcium † in 70 per cent. alcohol, add a little alum and filter.

* May be used after all hardening fluids.

† Chloride of calcium, according to Kleinenberg, has no other use than to strengthen the osmotic action between the hæmatoxylin solution and the alcohol contained in the tissues. As chloride of calcium and alum give a precipitate of gypsum, it would probably be better to use *chloride of aluminum.*

2. One volume of No. 1 mixed with six to eight volumes of 70 per cent. alcohol.

3. At time of using, pour into No. 2 as many drops of a concentrated solution of crystallised hæmatoxylin in absolute alcohol as will suffice to give the required depth of colour.*

If the colour appears too strong, the fluid may be diluted with solution No. 1.

Before immersing objects in this fluid, great care should be taken to free them from the least trace of acid by frequently changing the alcohol. If this is not done thoroughly, the acid left in the preparation will sooner or later cause the colour to fade; and such results have led to the erroneous conclusion that hæmatoxylin will not give durable preparations. Dr. Mayer has found that the fading is entirely due to the presence of acid, and that, with proper precautions, the staining is permanent.

Small objects are best stained in a weak solution, which colours more slowly but with greater clearness than stronger solutions. After staining, Kleinenberg transfers objects to 90 per cent. alcohol. In case of over-staining, the colour may be partly removed by adding a little *oxalic acid* or *hydrochloric acid* ($\frac{1}{2}$ per cent. or less) to the alcohol containing the objects. The acidulated alcohol is allowed to work until the colour is slightly reddened. On transferring to pure alcohol, the colour passes again into a permament blue-violet.

2. **Mayer's Cochineal tincture.**—1 gramme powdered cochineal soaked in 8–10 ccm. 70 per cent. alcohol for several days, then filtered.

The clear deep red fluid thus prepared may, like hæmatoxylin, be used in all cases where it is desirable to stain with an alcoholic solution, and will be found particularly useful for objects that are not easily penetrated by the ordinary aqueous solutions of carmine, such as the Arthropods.

* A good solution should be violet inclining a little to blue. The red tinge that arises after the fluid has stood for some time, indicates that it has become slightly acid, in which condition it is unfit for use. To restore its proper colour, it is only necessary to open a bottle of ammonia over the mouth of the bottle holding the hæmatoxylin in such a manner that a very small quantity of the gas will mix with the fluid. If too much ammonia gas be added, a precipitate is produced which spoils the fluid.

It is necessary, before immersing larger objects in this fluid, to leave them a short time in 70 per cent. alcohol, otherwise there may be a precipitate. The time required for staining will vary from a few minutes to even days, according to the nature and size of the object. With larger objects requiring considerable time, it is important to use a large quantity of the fluid, otherwise the amount of colouring stuff in solution might not suffice to give the proper depth of colour. Small and delicate objects, on the other hand, may be most successfully treated with a solution which has been diluted with 70 per cent. alcohol, or one which has been weakened by previous use. It is always necessary to free the tissues, after staining, from the surplus dye; and this may be done by washing in 70 per cent. alcohol, which must be changed until it shows no colour. This process requires, for larger objects, considerable time and alcohol, but may be hastened by using the alcohol slightly warm.

The colour ultimately assumed by objects treated with cochineal tincture varies much, and depends partly on the reaction of the tissues themselves, partly on the presence or absence of certain salts. It is certainly one of the best recommendations of this staining agent that, varying with the nature of the object and its mode of treatment both before and after staining, it gives such an extraordinary diversity of results. On account of the great variety of substances contained in the dried dye-stuff, it is evident that the composition of the tincture must vary according to the strength of the alcohol employed as a solvent. Solutions in 90 per cent. or 100 per cent. alcohol have a light red colour, and stain too diffusely to have any practical value. The weaker the alcohol the stronger the tincture, and the stronger the alcohol the more easily it penetrates objects; the grade of alcohol may therefore be selected with reference to two points, depth of colour and readiness of penetration; 70 per cent. or 60 per cent. is recommended by Dr. Mayer as combining both these qualities in a very favourable degree. It is important to remember that whatever be the strength of the solution, a precipitate will always be produced if an alcohol of a different grade, whether higher or lower, be mixed with it. It is evident, then, that a tincture of any given strength, contains substances that are insoluble in any other grade of alcohol, and this explains why superfluous colouring matter can only be removed from objects by the aid of alcohol of precisely the same degree as that of the tincture.

Over-staining, which seldom occurs, may be easily corrected by the aid of acid alcohol (1-10th per cent. hydrochloric acid, or 1 per cent. acetic acid). Acid makes the tincture lighter, more yellowish-red, while the addition of ammonia and other caustic alkalies changes it to deep purple. Still more important is the fact that salts soluble in alcohol give a blue-grey, green-grey, or blue-black precipitate. For example, if a piece of cloth that has been dyed in cochineal and washed, be treated with an alcoholic solution of a ferric or a calcic salt, it will assume a more or less deep blue colour.

As the salts present in the living organism are seldom, if ever, fully removed by preservative fluids, but in some cases even increased, it will often happen that an object, though stained in the red fluid, comes out blue, precisely as when stained with hæmatoxylin. Such a result cannot, however, be obtained in the presence of acids, nor in the absence of inorganic salts; under these conditions the colour is always red. It is not possible, therefore, to know what colour an object will ultimately present.

Very often the different tissues of one and the same object present unlike colours. In the embryos of *Lumbricus*, Kleinenberg found the walls of the blood-vessels red, their contents dark blue. Glandular tissues, or their contents, are frequently stained grey-green.

Objects treated with chromic or picric solutions, or with alcohol, usually stain without difficulty; but osmic acid preparations should be bleached before staining. Cochineal does not colour so intensely as hæmatoxylin, and hence the latter often gives more satisfactory results in the case of large objects stained *in toto*.

As before pointed out, alcohol causes the salts contained in sea water to be precipitated, thus forming a crust on the exterior of the animal which interferes with the staining process. It is therefore necessary to treat marine animals that have been preserved in strong alcohol with acid alcohol (1–10 parts hydrochloric acid to 1,000 parts 70 per cent. alcohol), and then carefully wash in pure 70 per cent. alcohol before staining with cochineal.

3. **Picro-carmine.**—A very excellent picro-carmine is prepared by Dr. Mayer in the following manner :—

To a mixture of powdered carmine (2 g.) with water (25 ccm.), while heating over a water bath, add sufficient ammonia to dissolve the carmine. The solution may then be left open for a few weeks (Mayer), in order that the ammonia may evaporate ; or the evaporation may be accelerated by heating (Hoyer). So long as any ammonia remains, large bubbles will form while boiling, but as soon as the free ammonia has been expelled, the bubbles will be small and the colour of the fluid begin to be a little lighter. It is then allowed to cool, and filtered. To the filtered solution is added a concentrated aqueous solution of picric acid (about four volumes of the acid to one of the carmine solution).*

In order to protect this fluid against changes attributed by Hoyer † to Bacteria, Dr. Mayer places a small crystal of *thymol* in the containing bottle ; Professor Hoyer uses *chloral-hydrate* (1 per cent. or more) for the same purpose.

4. **Acetic Acid Carmine.**‡—Pulverised carmine added to a small quantity of boiling acetic acid (45 per cent.) until no more will dissolve ; filtered and diluted to about 1 per cent. for use.

Flemming used the concentrated solution.

5. **Grenacher's Carmine Solutions.**§—(1) **Alum Carmine.**—An aqueous solution of alum (1–5 per cent., or any degree of concentration), boiled with ½–1 per cent. powdered carmine for 10–20 minutes ; allowed to cool, then filtered.

With the addition of a little carbolic acid the fluid will keep for years. It colours quickly, and nuclei more strongly than other parts. Objects should be washed in water after staining.

(2) **Acid Borax Carmine.**—*a.* An aqueous solution of *borax* (1–2 per cent.) and *carmine* (½–¾ per cent.) heated till the carmine is dissolved.

* The addition of the acid should cease before a precipitate begins to form.

† Hoyer. "Beiträge z. histolog. Technik." In Biolog. Centralblatt, B. II, pp. 17–19.

‡ Schneider. Zool. Anzeiger, No. 56, p. 254, 1880.

§ Grenacher. "Einige Notizen z. Tinctionstechnik." Arch. f. Mik. Anat., Vol. XVI., p. 463, 1879.

None of these solutions to be used where calcareous parts are to be preserved.

b. *Acetic acid* added by drops to solution *a*, while shaking, until the colour is about the same as that of Beale's carmine.

c. Solution *b* left standing twenty-four hours, then turned off and filtered.

This solution, which is a modification of Schweigger-Seidel's acid carmine, is not recommended for colouring *in toto*. It colours sections in ½–3 minutes diffusely, and hence, after washing in water, they are placed for a few minutes in alcohol (50 or 70 per cent.), to which a drop of hydrochloric acid has been added; then transferred to pure alcohol.

(3) **Borax Carmine.***—*a*. An aqueous solution of *borax* (4 per cent.) and *carmine*, heated till the carmine is dissolved.

b. Solution *a* mixed with 70 per cent. alcohol in equal parts, left standing twenty-four hours, and filtered.

This fluid may be used for colouring objects *in toto*. After staining, the objects are to be washed in 35 per cent. alcohol, to which a little hydrochloric acid has been added (4–6 drops to 100 ccm.), and allowed to remain there until the colour has been sufficiently removed. They are next passed through successively higher grades of alcohol for hardening.

(4) **Alcohol Carmine.**—A teaspoonful of carmine dissolved, by heating about ten minutes. in 50 ccm. of 60–80 per cent. alcohol, to which 3–4 drops of hydrochloric acid have been added, then filtered.

Objects coloured in this fluid should not be washed in water, but in alcohol of a grade corresponding to that of the solution.

For diluting alcoholic solutions of carmine, alcohol of the same strength must always be used.

6. **Aniline Dyes.**—As a rule, aniline colours and the many others obtained recently from tar by chemical processes, cannot be used for staining objects *in toto*, and are therefore not much employed in the Zoological Station. In very small objects and sections already cut, very excellent results can be obtained by the

* Dr. Mayer prepares, for some purposes, borax carmine of 50, 60, or 70 per cent. That of 70 per cent. contains little carmine, but is well adapted to staining delicate objects that would suffer if exposed to weaker solutions. Boiling alcohol (50 per cent. or 60 per cent.) dissolves about 1 per cent. carmine and 1 per cent. borax.

methods developed by Böttcher,* Hermann,† Flemming,‡ and others; for here diffuse staining may generally be avoided by first over-staining, and then withdrawing the colour to any desired extent by means of alcohol. But to obtain satisfactory results, the sections must be thin enough to allow uniformity of action both to the colouring and the decolouring agent. It is evident that the process cannot be similarly controlled in larger objects, particularly where a dye is used, which, like most of those under consideration, is quickly extracted by alcohol, for in this case the colour would be removed from the superficial layers more rapidly than from the deeper ones, so that a uniform precision of colour would be impossible. In this respect,

a. **Bismarck-brown** forms an exception. The preparation of this dye, introduced by Weigert,§ is extremely simple:—

A saturated solution is made by dissolving the powder in boiling water or weak alcohol, or, according to Mayer, in 70 per cent. alcohol.|| The solution should be used undiluted, and requires to be filtered from time to time. It colours very quickly objects hardened in alcohol or chromic acid.

b. **Safranin.**—1 part *safranin* dissolved in 100 parts of *absolute alcohol;* after a few days 200 parts of *distilled water* is added.

Dr. Pfitzner,** from whom the above formula is taken, recommends this solution as one of the best for staining nuclei. It is cheap, easily prepared, acts quickly, and stains *only* the nuclei. It works best with chromic acid preparations, from which the acid has been removed as much as possible.

7. **Flemming's methods of treating Nuclei.**—The method employed by Böttcher and Hermann of *over-staining* objects with aniline dyes, and then removing the colour to any desired extent by the aid of alcohol, formed the starting-point of the methods

* Böttcher. *Mul. Archiv.*, 1869, p. 373. Virchow's Archiv., Bd. XL., p. 302.

† Hermann. Communicated to the Naturforscherversammlung in Graz, 1875. Tagblatt, p. 105.

‡ Flemming. Archiv. f. Mikr. Anat., Bd. XIII., p. 702, Bd. XVI., p. 302, Bd. XVIII., p. 151, Bd, XIX., p. 317 and p. 742, B. XX., p. 1.

§ Weigert. Arch. f. Mik. Anat., Bd. XV., p. 258, 1878.

|| According to Flemming, it may also be dissolved in dilute acetic acid.

** Pfitzner. Morph. Jahrb., VI., pp. 478-80 and VII., p. 291.

recently published by Flemming. The following is a summary of the more important conclusions reached by Flemming * :—

A. **For Nuclei in general.**—1. Objects hardened in *chromic acid* (1–10 per cent. to ½ per cent.).

The time will vary according to the nature of the object.

2. Carefully washed in distilled water.

3. Stained directly, or further hardened in weak, and then in strong alcohol.

Safranin, *Magdala red* (rose de napthaline) and *dahlia* (monophenylrosanilin) give the best staining. Safranin prepared as given above; magdala in the same way; dahlia is best dissolved in water, or acetic acid.

Only very small objects, or thin sections, can be successfully stained, and these should be left in the fluid 12–24 hours.

4. Objects transferred to weak alcohol (70 per cent.) and shaken for a few moments; then placed in absolute alcohol for half a minute or longer, till no visible clouds of colour appear. The process of decolouring is now completed, and the objects must be at once removed from the alcohol, otherwise the colour will be too much weakened. If it be required to examine the objects before mounting, they may be removed to distilled water, in which the colour of the nuclei will remain unchanged for a considerable time. They must then pass through alcohol again before mounting.

5. Clarified in clove-oil and mounted in *dammar-lac.*†

Clove-oil withdraws the colour a little, and hence it must not be allowed to work too long. Creosote extracts the colour still more rapidly than clove-oil.

B. **Eggs of Echinoderms.**‡—In his recent researches on karyokinesis, Flemming states (p. 5) that he obtained serviceable staining of nuclei in the following ways :—

1.—*Living eggs coloured on the slide*, either with *safranin* or *aniline dyes*, followed by acetic acid (1 per cent.), which is allowed

* Flemming. Archiv. f. Mik. Anat., Vol. XIX., p. 321.

† Probably balsam dissolved in chloroform would answer the same purpose.

‡ Flemming. "Beitrage zur Kenntniss der Zelle und ihrer Lebenserscheinungen." Arch. Mik. Anat., Vol. XX., p. 1, 1881.

to flow under the cover, and thus replace the staining medium, or with

Acetic acid carmine (after Schneider), used undiluted. The last-mentioned staining agent causes swelling, but still gives the typical features of the karyokinetic figures.

2. Eggs first hardened in strong nitric acid (40–50 to aq. dest. 60–50), then washed in distilled water until the yellowish colour, due to the presence of the acid, disappears. Coloured with acetic acid carmine.

III.—Methods of Dissecting.

For the dissection of single organs, fresh animals are generally placed in dilute alcohol, or a weak chromic solution. But the tissues are liable to suffer from maceration in these fluids, and hence, where it is important that the tissues should be well preserved, it is advisable to use picro-sulphuric acid, regardless of the injurious effects of the same on the dissecting instruments. The hardening capacity of the picro-sulphuric acid is extremely slight, but may be strengthened by the addition of chromic acid. Preparations thus obtained, and subsequently treated with alcohol, staining fluids, etc., should be transferred to creosote for further dissection, as the transparency induced by this medium will greatly facilitate the work.

IV.—Imbedding.

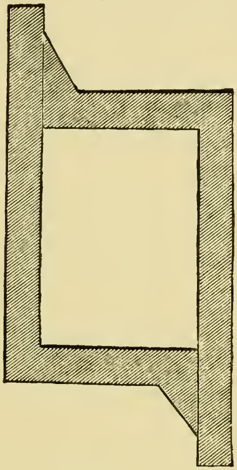
For section cutting, objects are usually imbedded in paraffine, but in low temperature, as in winter, it is necessary to work with a softer paraffine than is required for summer. Instead of softening by an admixture of lard, as is generally done, it is better to use a paraffine which becomes soft in summer, on account of its containing liquid hydrocarbons.

Preparatory to imbedding, the objects are removed from absolute alcohol* to creosote, clove-oil or chloroform, and left until they become thoroughly saturated. The penetration of the clarifying fluid may, in some cases, be advantageously hastened by warming a little. They are next placed in soft paraffine, heated to about 50° C. over a water bath, and allowed to remain for an hour or so. The soft paraffine is then turned off and replaced by

* In many cases a lower grade of alcohol will suffice.

a mixture of hard and soft paraffine,* heated to about 50° C. After remaining for half an hour or less in the harder paraffine, kept at a steady temperature, they are ready for imbedding. For this purpose a small paper box may be used; or, much better, a box made of two pieces of type-metal, as used in Professor Leuckart's laboratory. As will be seen from the accompanying diagram, each piece of metal has the form of a carpenter's square, with the end of the shorter arm triangularly enlarged outward. A convenient size will be found in pieces measuring 7 (long arm) by 3^{cm} (short arm), and 7^{mm} high. With such pieces a box may be constructed at any moment by simply placing them together on a round plate of glass, which has previously been wet with glycerine and gently warmed. The area of the box will evidently vary according to the position given to the pieces, but the height can be varied only by using different sets of pieces. In such a box the paraffine may be kept in a liquid state by warming now and then over a spirit-lamp, and small objects be placed in any desired position under the microscope.

Fig. 25.



It is well to imbed in a thin layer of paraffine, so that the object, after cooling, may be cut out in small cubical blocks, which may be easily fixed, for cutting, to a larger block of hard paraffine.

V.—Cutting.

Objects are cut dry with a microtome,† and the rolling of the sections may be prevented by holding a thin narrow spatula over the edge of the knife while cutting. The spatula may be made of brass, or paper fastened to a flattened needle. The spatula should

* The ratio of combination must be determined by experiment, since it will depend on the quality of the paraffine and the temperature. Two parts of hard to one of soft, work very well for the winter temperature of Naples.

† An improved form of Thomès' microtome is made by Rudolph Yung, Heidelberg, Hauptstrasse 15. The carrier is moved by a micrometer screw, and the holder can be adjusted in any desired position.

be slightly bent, and its convex face held over the paraffine without pressure, A small brush, slightly flattened, is used for the same purpose in Leipsic.

VI.—Giesbrecht's Methods.

(1) **Transferring from Alcohol to a solvent of Paraffine.***— To avoid shrinkage in transferring tender objects from alcohol to chloroform or an oil, pour a little absolute alcohol into a small glass tube, place the canular end of a pipette containing the solvent below the surface of the alcohol, and allow a few drops to flow from it to the bottom of the tube; into this tube let fall, by the aid of another pipette, or a small spatula, a few drops of absolute alcohol containing the objects to be imbedded. The objects will sink through the alcohol, which, being the lighter fluid, has taken a superjacent position, and rest on the upper surface of the fluid expelled from the first pipette. Most of the alcohol may now be removed by a pipette, and the objects left to sink gradually into the heavier fluid at the bottom of the tube. In this way the replacement of the alcohol contained in the objects by an oil, or some solvent of paraffine, is much retarded, and thus the danger from shrinkage reduced to a minimum.

Where chloroform is preferred to creosote or oil of cloves, a little ether (*æther sulfuricus*, C_4H_5O) should be added, as many objects will not sink in pure chloroform.

To replace alcohol by a solvent of paraffine, and then by paraffine itself, is an operation which may, in many cases, be readily accomplished by employing any one of the ordinary intermedia, such as oil of cloves, bergamot oil, creosote, turpentine, chloroform, etc. But with tender objects, particularly those with larger or smaller internal cavities, the process is often attended with great difficulties, and in such cases collapse and shrivelling can only be avoided by giving the most careful attention to every step in the process.

Dr. Giesbrecht recommends, for difficult cases, chloroform,† as it is one of the best, and at the same time the most volatile solvent of paraffine.

* Giesbrecht. "Zur Schneide-Technik," in Zoolog. Anzeiger, 1881, No. 92.

† Bütschli (Biolog. Centralblatt, B. 1, p. 591) has also recommended chloroform, entirely overlooking, as it would seem, Dr. Giesbrecht's prior publication.

(2) **Transferring from Chloroform to Paraffine.**—After the objects have become thoroughly saturated with chloroform, the containing tube is placed on a water bath and heated to about 50° C.—the melting point of paraffine; then a small piece of paraffine is added and allowed to dissolve, and this is repeated until bubbles cease to rise from the objects. To make sure that the chloroform has been fully expelled, the objects may next be transferred to pure paraffine, and left for a few minutes before imbedding.*

(3) **Shellac as an aid in Mounting.**—The use of *shellac* for fixing sections on the slide, introduced by Dr. Giesbrecht,† is a very valuable addition to histological methods. By this method hundreds of small sections may be arranged in serial order, and all inclosed in balsam under the same cover without danger of disarrangement. The method is further extremely useful in mounting larger sections, particularly those composed of loose parts, or parts liable to swim apart.

The shellac is prepared and used in the following manner:—One part of bleached shellac, ‡ mixed with ten parts absolute alcohol, and filtered. The object-glass is first warmed to about 50° C.,§ and then a thin film of the shellac is laid on by a glass rod drawn once over its surface. Before using, the slide is again

* For the Hydrozoa, Professor Weismann prefers turpentine to chloroform, as where the latter has been used, the paraffine is liable to be more or less spongy in consequence of bubbles lodged in the tissues.

Turpentine renders objects brittle, and on this account chloroform will, in many cases, give better results. The spongy state of the paraffine results from the fact that the chloroform has not been allowed to wholly escape.

In the case of the *Actiniæ*, Dr. Andres employs a mixture of turpentine, creosote, and alcohol, using successively mixtures containing more turpentine and less alcohol, thus:—

Mixture No. 1.		No. 2.	No. 3.	No. 4.
Turpentine	1	2½	4½	7½ parts.
Creosote	2	2½	2½	2½ ,,
Alcohol (absolute)	7	5	3	0 ,,

† Giesbrecht. "Methode zur Anfertigung von Serien-Praparaten," in Mittheilungen a. d. Zoolog. Station, zu Neapel, 1881, p. 184.

‡ Dr. Mark informs me that he uses "the bleached shellac in the form in which it is prepared for artists as a '*fixative*' for charcoal pictures. It is perfectly transparent, and a film of it cannot be detected unless the surface is scratched." Dr. Mark attaches a small label to the corner of the slide, which serves for the number of the slide and the order of the sections, and at the same time marks the shellac side (otherwise not distinguishable).

§ The same temperature is used throughout the operation.

warmed, and the shellac surface washed with oil of cloves for the purpose of softening it. The wash is made with a small brush drawn back and forth until the entire surface has been moderately but evenly wet with the oil. Sections are now cut and arranged for the first cover; this done, the slide is warmed over a spirit-lamp so that the paraffine adhering to the sections melts and flows together, forming an even layer, which cools almost instantly, and thus secures the position of the sections, while those of the second cover are prepared. The sections for the last cover having been completed, the slide is warmed for ten minutes on a water bath, in order that the sections may sink into the shellac and become fixed, and the clove-oil evaporate. After allowing the slide to cool, the process is concluded by washing away the paraffine with turpentine, and inclosing in balsam dissolved in chloroform.

VII.—Gaule's Method.

Since the above was written, my attention has been called to the following mode of fixing sections, first described by Dr. Gaule: *

1.—Sections cut dry and placed on the slide in the order and position in which they are to be mounted.

2.—They are then smoothed out by the aid of a fine brush wet in 50–60 per cent. alcohol, until all wrinkles are removed and every part is in close contact with the slide.

3.—Slide allowed to stand several hours (or over-night) until the alcohol has completely evaporated, and the sections are left adhering quite firmly to the glass. The process may be hastened by gently warming to 45–50° C.

4.—The paraffine may be removed by any of the solvents in common use, but Dr. Gaule recommends Xylol. A few drops are allowed to flow over the sections, and after a few moments the paraffine is fully dissolved.

5.—The balsam (a mixture of balsam and xylol in equal parts) is placed on the cover-glass, and this allowed to sink slowly, from one side, over the sections.

Dr. Gaule finds it convenient, especially with serial sections, to use large cover-glasses—often nearly as large as the slide itself. Thus a single slide may often contain a large number of sections closely arranged under one cover.

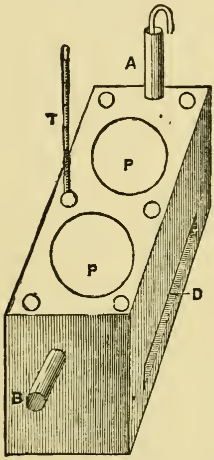
* Archiv. f. Anat. u. Phys., 1881, Phys. Abthlg., p. 156.

For large sections this method offers one important advantage over that of Dr. Giesbrecht; for by the former all wrinkles may be removed, while by the latter the sections must lie as they fall. In the case of smaller sections, not liable to get wrinkled during the placing, I prefer the shellac method.

Water Bath.

The diagram represents a convenient form of water-bath, devised by Dr. Mayer.

Fig. 26.



It is a small brass box, 18^{cm} long, 9^{cm} wide, and 8^{cm} high. The tube, *a*, through which the water is received, and the rod, *b*, serve as handles. The receiving tube is closed by a cork provided with a glass tube for the escape of steam, this is bent in the form of a siphon to protect against dust. One and a-half centimetres from the base of the box is an oven (*o*), 7^{cm} high and 12^{cm} long, which passes completely through the box, and serves for warming the slides when shellac is used. Above are seen two circular basin-like pits (*p.p*), 5.5^{cm} in diam., and 4^{cm} deep, for receiving the two tin paraffine holders. These are covered by circular plates of glass. There are also six tubular pits: one for a thermometer (*t*), the others for glass tubes.

This water-bath will be found useful for other purposes than those of imbedding and mounting. It will of course be understood that the purpose in giving its exact dimensions is simply to furnish a guide where one is required. There are at least two important advantages offered by this water bath over those in general use, viz.—the slides are protected from dust, and the paraffine is not exposed to the water.

Half-an-Hour at the Microscope,
With Mr. Tuffen West, F.L.S., F.R.M.S., etc.

PLATES 40 AND 41.

BEING from home on a much-needed short holiday, my remarks on the slides here presented must necessarily be brief. And it is the less needed from the satisfactory evidence the foregoing notes (see *post)* give, that so many of our members are now helping us, to *mutual* profit, by useful remarks on the structure, relations, habits, etc., of the various objects as they come before us.

I have seemed to myself to be taking far more than is my share of this kind of work; but it has only been to stimulate others by my own example. A member who simply says when his slide goes in, "I put" so and so "into the box," only wastes paper and ink by so doing; the way-bill and the index *should* inform us of that! Others are pleased to say that we "shall find it interesting." That may or may not be; it is for *them* to make their slides so by informing us what the object is, whence obtained, how prepared, how mounted, what it shows, its connection with allied objects, *especially such as have been before us already.* This, with appended figures, is simply their duty. *Then* it remains for others to add to the store of knowledge, by imparting whatever else of interest and instruction may be in their power. By following this, the proper course, a very serious loss of time to other members would be saved, as well as much useless repetition in the Notes, whilst the stores of our common knowledge would be continually increasing.

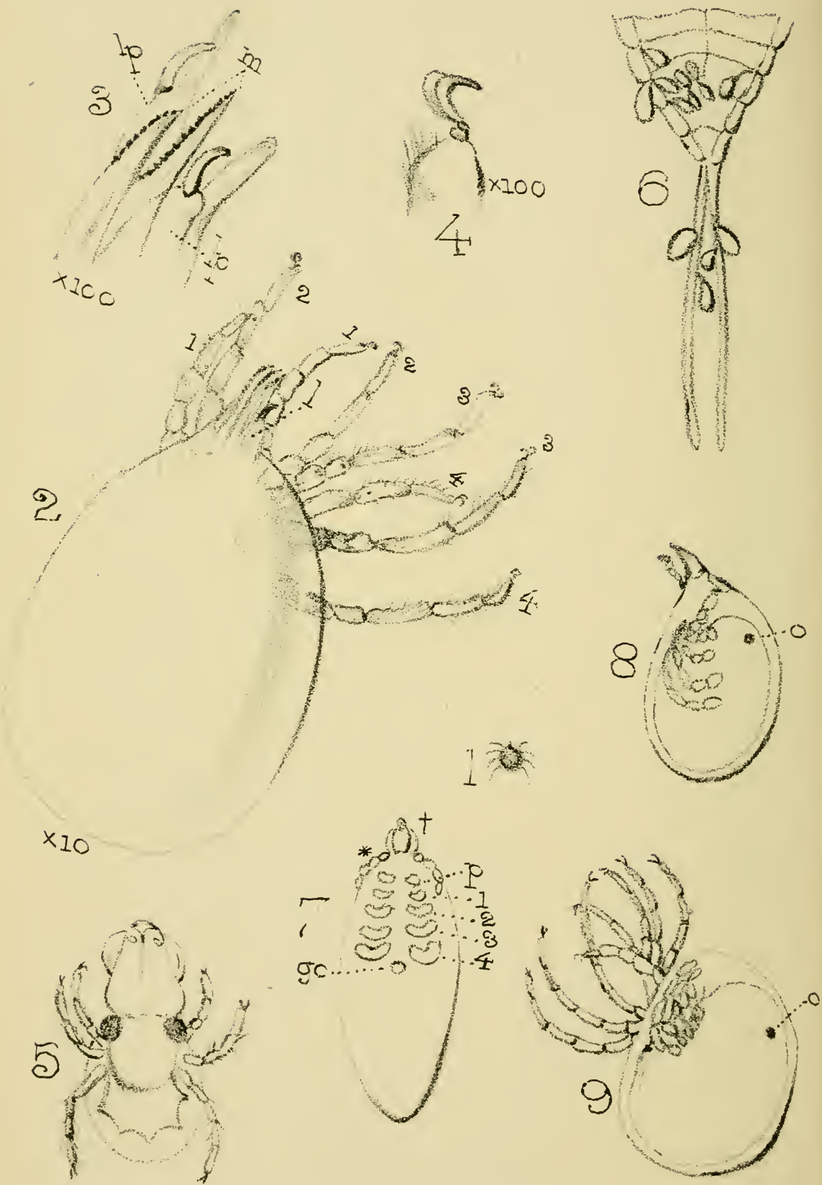
To say, "*I like this,*" and "*I don't like,*" or "*don't care about that,*" adds not one particle to our knowledge. The whole thing is to my mind so simple. An intelligent friend drops in to spend an hour over the microscope with you. A few objects are looked over. He draws out of you by various questions what you know, imparting at the same time such information as he can, and when "Good bye" time comes at last, both can look back upon the time so spent as having been mutually satisfactory and profitable.

Epithemia argus.—To study the Diatomaceæ, it is necessary to take carefully into account, not only entire forms, but also such as are present in fragments, *these answering to the* "DISSECTIONS" *of* *larger structures.*" *E. argus* is especially interesting in this respect; and without a good deal of the knowledge (only to be gained by experience), it is somewhat difficult to mentally unite all the various pieces into which these Diatoms break up. This is scarcely distinct as a species from *E. ocellata*, under which name some of the specimens on this slide might be placed.

Pollen of Mallow (Pl. 40).—This is a remarkably fine specimen; its beauty and interest recommend it to microscopists of every degree of attainment, so that it is no wonder it is a universal favourite wherever introduced. I know nothing better for showing to the uninitiated the beauteous appearance of the fine dust so hastily brushed from flowers, so thoughtlessly regarded by most, yet so essential to the economy of the plant. The union of the staminal filaments into a tube, whence the name "*monadelphous*," is well shown here; at the base of this tube note the rough hairs, whose use is probably to retain the precious dust as it falls, that none be lost. Most anthers are "two-celled," or "*bilocular;*" capital examples of this will be seen presently in those of tulips or lilies. The anthers of *Malvaceæ*, however, depart from this type (it is supposed by suppression of one of the lobes), and hence are regarded as "*unilocular.*" The form of pollen seen here, "spherical," with the "outer coat granular and spiny," and "pores scattered irregularly over the surface," is one of the characteristics of the Mallow tribe. It would be desirable to know from what species this came, and how it was secured in such prime condition. I should expect to get it by slitting the tube into half with a sharp knife very soon after opening, popping on to a slip with cover, but without other pressure, and keeping in a moderately damp place to favour the opening of the anthers, and yet retain the pollen as it escaped. I have seen pleasing modifications in the mode of mounting this object, the petals being retained, and shown so far as the size of the glass would allow. This, when skilfully managed, makes a desirable addition to its beauty. It may be remembered that one of the Pollen-baskets in the slide of "Hind Limbs of Humble-Bee," shown by R. H. Moore, had a mass of Malvaceous pollen in it, probably from the hollyhock, as that is a favourite flower with them. From the Pollen-basket of the other limb this had been removed.

Parasite of Dyticus (Pl. 41).—Probably few of us but are familiar with a beautiful little scarlet mite, which looks, as it goes merrily bobbing about in the water, like an animated bead of the most brilliant red coral. Its name is *Hydrachna globula.* Voracious enough after reaching maturity, its early life is just one act


s
s
3
×50
s
2
×18
1
×8
4
×50


3
b
b'
b
x100
4
x100
6
2
1
2
1
2
3
3
4
4
x10
1
8
o
7
p
1
2
3
4
gc
5
9
o

of intermittent suction. The eggs are laid in a mass underneath the floating leaves of some aquatic plants, notably *Polygonum amphibium.* To these leaves they are firmly fixed by an abundant secretion, that hardens under water to the consistency of dense horn, or even becomes almost stony. Incubation occupies but a few days in hot weather. When hatched out, the young, provided with three pairs of limbs, robust palpi, and a pair of large eyes, swim rapidly about in search of some water-insects, to which to affix themselves, which is done by inserting the powerful beak shown in the example before us. The favoured (?) hosts are *Nepa cinerea* and *Dyticus marginalis*, which may be sometimes found bearing numerous examples. Their appearance now becomes entirely changed ; the skin is cast, whilst the body greatly increases in size, becoming meanwhile pear-shaped. This condition lasts for some time ; during it, rudimentary limbs form internally, which gradually undergo segmentation, and the seat of the future genital orifice is distinguishable. The soft limbs are now withdrawn from their investment, a pair of eyes become visible ; and when growth has sufficiently proceeded, another moult takes place, the old slough is cast, and they swim freely about like their parents. After shedding the skin yet once more, the sexual organs become fully developed, and they are ready to reproduce their kind. And thus the curious cycle of their life history is completed. The time of writing (July) is exactly that for repeating these observations, and I have not found *Hydrachna* difficult to keep in aquaria, under suitable conditions, long enough for the purpose.

Those who desire fuller information will find it in an early volume of " *Annales des Sciences Naturelles*," a contribution by M. Dugès, or (abstracted) in the later editions of Prof. T. Rymer Jones's " *Outlines of the Animal Kingdom.*"

In "*Science Gossip*" for November, 1865, at p. 255, occur figures by Dr. Lewis G. Mills, of the larval parasite, evidently taken from specimens mounted, and somewhat distorted in the process.

In connection with this slide, I should like such members as can, at the first opportunity, whilst it is still fresh before us, to exhibit the different phases in the creature's existence :—

1.—The Eggs of *Hydrachna globula.*

2.—The Young, newly hatched.

3.—The Larva, as first attacking its host (the so-called "*Achlysia*").

4.—The Larva in its second stage—the "*Leptus-form.*"

5.—The young creature in its free condition, with six limbs only ; and, lastly,

6 and 7.—Mature individuals of both sexes.

To make the series complete, slides would also be necessary to show, by dissections, the skin, the trophi, and the limbs, in the various modifications.

Spicules of Tethea cyncurium.—Tethea is a sponge, of a rounded form; some specimens reach the size of a cricket-ball, or larger; others do not go beyond a large marble in size. It differs from most sponges in its solidity, and the possession of an outer skin, so that it might be likened in appearance to some of the Puff-balls. I remember the delight with which Bowerbank showed a number of specimens that had been obtained by deep-water dredging off the Shetlands a great many years ago. In the "Micro. Dictionary" only two species are mentioned, but I suspect there are more known now. The similarity of these Sponge spicules to acicular and stellate raphides will strike the thoughtful observer, and the analogy is neither a fanciful nor a forced one. The stellate ones represent the sphæraphides so abundant in the Cactaceæ especially, and the office of both is partly to give firmness to the soft tissues in which they occur. And some of the large acicular spicules show a laminated growth with central vacuity, such as may be seen in some of the large vegetable hairs; those on the leaf of the Hollyhock to wit.

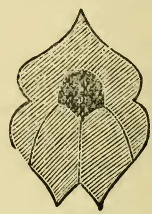
Palæmon serratus jun.—A very interesting slide. I should have liked to have seen some specimens presenting the side-view, others laid on their backs. R. Warington will be remembered as the inventor of the aquarium, through discovering the grand law of the balance of animal and vegetable life. He had a large mass of most careful observations, which he designed to publish. I never knew why this was not done, and fear that by his death they are now lost to science.

Argas reflexus is figured in the Crochard edition of Cuvier's "Regne Animal." The figure is a beautiful one, and, I believe, correct as far as it goes. I have no doubt in my own mind that it is the large "Tick" which Henry Denny mentions his having found on Pigeons ("Monographia Anoplurorum Britanniæ," p. 173); we must try and trace the specimen to clear up the matter. As they are well known to be parasite on Pigeons, all difficulty is removed as to how they got into the Cathedral (these ticks were discovered by Mr. Jas. Fullagar, of Canterbury, in the Cathedral of that city), since we are told that jackdaws and pigeons had roosted there from time immemorial (Fullagar in "Science Gossip," June, 1874, p. 121). It would be satisfactory to know more of the history of this particular specimen. I think we are safe in assuming that she had satisfied her appetite, and had sought out at the time of capture some cranny wherein to deposit her eggs. The males would probably be much smaller, more active, and difficult to find. "A species occurring in Persia lives in houses, and by its puncture occasions convulsions, delirium, and sometimes, as is asserted, even death." *Argas persicus* FISCHER, GERVAIS *Apteres*, III., pp. 229—231, Pl. 33, Fig. 6 ("Handbook of Zoology," Van der Hoesen, Vol. I., p. 578). This is not the place at present to go into minute details, but much may be learnt by a careful study of the specimens by our members individually. Remember one of the remarks of "Owen the Great"—"The eye sees in proportion to the knowledge which the mind brings to the investigation." You know, too, Wordsworth's pedlar :—

"A primrose by the river's brim,
A yellow flower it was to him;
And it was nothing more."

Whilst to Darwin it has served as a "master-key" to unlock the treasury of knowledge in chamber after chamber of eternal truth. See "Researches on di-tri-Morphism in Primulaceæ, Linaceæ, Lythraceæ, etc." (Proc. Linn. Soc.). Mr. Fullagar's description is most interesting. On looking over it, I see that this is "one of two specimens" "found on the wall of the passage that leads from the Cathedral to the library, April 20th, 1872," and "placed in a glass-topped box, in which they lived for one year and ten months." On June 27th, 1882, he says :—"I found they had laid a large number of eggs, which were quite round and of a reddish-brown colour, smooth, and very bright, having the appearance of small glass beads" (loc. cit., p. 121). They hatched out in about 9 or 10 days, and the young lived for six months without food. Absence of eyes is a general characteristic of the Ixodea. I cannot understand how it comes to be stated that "they have no suctorial proboscis, like the common Tick," for this specimen shows them to have, though not with sufficient clearness for exact description, and it is shown in Mr. F.'s own figure as well, on p. 122. They are formed to endure long fasts, but the statement that they are capable of living without food "for four or five years" is highly improbable, and requires verification. The corrugations of the integument, best seen on the back of the creature, interest me much, resembling as they do most closely those met with on the seed of *Stellaria graminea* (the Greasy Stitchwort). Mr. Gulliver states that the "white dots" are calcareous; is not this curious? It has already been stated in our Notes, that the Ticks approximate in some respects to Crustacea; here we have an additional link—calcareous masses imbedded in "the carapace," forming a rudimentary skeleton in fact, and so beautifully disposed also, to form a chaste decoration as well! W. W. Spicer, in "Science Gossip," September, 1874, gives a good abstract of the literature of Argas (p. 209).

Ovipositor of Sirex gigas is a slide of the right sort. The insect much resembles a very large wasp with a long tail, and its sudden appearance at times in large numbers has caused much alarm in the minds of the ignorant. Its larva bores into the sound timber of Pines. "By the importation of deals containing it from Sweden and Norway, the insect has now become naturalised in this country on the Scotch fir, and is not uncommon in some parts where, as in this neighbourhood (Fareham), extensive pine-woods exist." Westwood's careful description of the borer in *Urocerus* ("*Sirex*" *olim*) has made me much wish to examine it when time and opportunity allowed, and now the splendid tool lies before me! What a blessing is our society to busy men! The form in section is represented thus—(Pl. 16, Fig. 72, p. 115, Vol. 2, Westwood's Modern Classification of Insects). This borer has been likened to a corkscrew, and on superficial examination there is a general resemblance, but it goes no further, and the comparison is calculated greatly to mislead. See Westwood's description, pp. 116, 117.



Eggs of Anthomyia.—These have a very close resemblance to the eggs of the Common House-Fly; if truly from an Anthomyia it would be satisfactory to know from what species. This, with other circumstances lately noted, tends to confirm my belief that the types of insects' eggs are comparatively few in number, and that it will often be very, very difficult to distinguish the species which may have yielded particular specimens of eggs.

I have found it a good plan to put gravid flies into two-ounce phials, with a little of some substance likely to tempt them to oviposit; the parent insect can then be secured, correctly named, the knowledge of the egg obtained, and, if time allow, the whole of its changes observed and preserved. There is an Anthomyia very destructive to onions in my garden, and another (in some seasons especially) to plants of the cabbage tribe, and last year I found some eggs, I think, identical with these on a decaying cabbage-stump.

Fish-Scales.—It is preferable to take them from one particular part—the lateral line, about one inch or so below the gill-opening, on the left-hand side, with one or two from next above, and an equal number from next below that line. Placed on the slide in this way, they tell their own tale. One may be shown with the integument still attached; it is necessary to remove it from the others to show the sinuous lines, spines, etc. (where any of the latter are present), clearly. I prefer them mounted dry. They cockle much in drying, which is best prevented by placing them between two slips of glass, on the upper of which a moderate weight may be placed.

TUFFEN WEST.

EXPLANATION OF PLATE XL.

Fig. 1.—Represents the staminal column of one of the Malvaceæ; perhaps *Malope grandiflora*, mag. 8 diam. The column appears to have been cut open in the preparation of the specimen and laid out flat. The anthers are unilocular (one-celled) and open inwardly. The pollen is globular, with the outer coat granular and spiny.

Drawn by Tuffen West.

,, 2.—*Spiridea filamentosa*, mag. 18 diam., showing the "filaments" and capsules, with the spores escaping therefrom.

,, 3.—Capsule of the same, mag. 50 diam., showing the spores and their mode of escape.

,, 4.—Delicately fringed branch.

Drawn by H. M. J. Underhill.

EXPLANATION OF PLATE XLI.

Fig. 1.—*Hydrachna globulus*, natural size.

,, 2.—The specimen exhibited on the slide of pupa, or "*Leptus-form*," mag. 10 diam. The young animal, in progress towards a higher phase, has been dissolved out by the action of potash. 1.1; 2.2; 3.3; 4.4; indicate the first, second, third, and fourth pairs of limbs respectively; *l.*, labium.

,, 3.—Trophi as found in this specimen, mag. 100 diam.: *m.*, the acute mandibles; *l.p.*, *l.p.*, labial palpi.

,, 4.—Claws and end of tarsus from the fore-leg of the first pair, and right side.

,, 5.—The young larva in its free-swimming state.

,, 6.—Hinder extremity of *Nepa cinerea*, with numerous examples in the attached parasitic condition of "*Leptus-form*," as shown in the slide.

,, 7.—"*Leptus-form*," young Hydrachna being developed within it: *p.*, rudimentary palp; 1.2.3.4., rudimentary, unsegmented limbs of the first, second, third, and fourth pairs respectively; †, head of larva; *, exuvium of its first pair of limbs still remaining attached; *g.o.*, genital orifice.

,, 8.—Side-view of "*Leptus-form*," with included young Hydrachna.

,, 9.—A further advanced condition; the young animal about to make its escape as a free, active swimmer.

Drawn by Tuffen West.

Selected Notes from the Society's Note-Books.

GEOLOGICAL.

Carb. Limestone Nodule.—This slide may be viewed either by hand-glass or by ½-inch o.g., and either way it will tell its tale. Describing the reverse from the hand-glass view, there are at least a dozen of what are called Stigmarian rootlets. The medulla is in each rootlet, but not in the centre of any. These are bundles of firm scaliform vessels, that had their origin in the vascular cylinder of the root. In some of the rootlets they are transverse, in others longitudinal. Outside of this medulla was a mass of cellular tissue very delicate, and therefore rarely preserved in the nodules; outside of the central or sub-central mass, was a cortical mass of denser cellular tissue. This is preserved more or less in this specimen, and constitutes the bark, if I may "forge" a term, of the Stigmarian rootlet. The dark masses in the centre are remains of ferns, the one or more species of the *Rachiopteris* tribe of Williamson. Transverse section of stem, with its beautiful vascular bundles enclosed in cellular bark, and all about the dark mass of the slide, may be seen various fragments of leaves, stems, and a spore or two of some species of the *Rachiopteris* tribe. Altogether the fragments on the slide amount to considerably over 100, so that in viewing this we see, not the whole certainly, but a superficial inch of a carboniferous forest, and as such it would be best to consider it. There is one caution, however; the more beautiful and delicate tissues of the *Stigmaria* are lost. Carnithers says that he has never once seen this tissue in all the material that has passed through his hand. I believe Williamson somewhere says the same, and although I have examined over 2,000 specimens, I have only seen it faintly and delicately preserved in one specimen alone, and I am therefore able to say that the tissues which surround the medulla in the rootlet are fine, delicate cellular tissues, similar in character to the outer bark, but with cell-walls of most remarkable fineness. In one of the specimens a small portion of this tissue is preserved.

G. R. Vine.

[We much regret that no drawing has been made to record the beauties of this extraordinary slide, and insert the notice simply to inform our readers what may be found, after careful search, in some of the Carboniferous Limestone Nodules.—EDITOR.]

Section of Limestone.—This is decidedly oolitic, and has very much the same structure as the Bath Oolite. How has this structure been produced? There must have been something to attract the lime (segregation) into concentric layers, although nothing is now to be seen within, other than crystals, whilst some of the granules are mere empty shells. This question of the origin is one of the open questions before geologists, and for my part I have never met with a satisfactory solution. I think that the granular structure is an after production, as the granules have no appearance of having been rolled about in water. Some of the concentric layers are very crystalline, and some granules contain crystals within. To account then for the formation of the granules, I should suppose that the carbonate of lime composing the granules, was in solution either in very cold water, deep water, or water containing more than usual of carbonic acid. This would amount to almost the same thing, as cold water holds more carbonic acid than warm water, and it has been ascertained that deep water contains more dissolved carbonic acid than shallow water. (This opens up the question as to whether oolitic limestones are deep or shallow water productions.)

The next stage would be the separation of the carbonate of lime from the water, leaving it in a solid form, and its formation into granules having concentric coats. This would be a process of segregation, but what could be the central point of attraction? In some books it is stated that foreign particles, such as flint, grains of sand, fragments of fossils, etc., can be seen within the granules. I can only say I have never seen them, although I have examined the structure for many years. Possibly some foreign substance was within each granule at one time, but nothing can be seen there now.

I think the structure must be classed with concretions in general, such as we see in various formations, *e.g.*, the clay-ironstones of the coal measures. Whilst rocks are soft and yielding, the impurities contained in them have a tendency to collect together into concretions. The diatoms which must be disseminated in all rock deposits, would thus collect together into siliceous masses still microscopic. Much of this siliceous matter would be dissolved if the water or rock became warmer. It is a fact, that if we mix silica with a solution of carbonate of lime, and afterwards heat the mixture, the silica will partially dissolve, and the lime will be deposited. This is owing to the escape of carbonic acid, which kept the lime in solution as bi-carbonate.

Now the question is, how did the dissolved lime pass from the soluble to the insoluble or ordinary form? (I should have stated that our oolitic freestones of the Cotteswolds are quite soft when quarried: you may stick a pen-knife into the soft stone; they are also damp or moist, but in a few days they became very hard and dry, and will turn the edge of the knife. The lime in solution has passed from the soluble to the insoluble form, through the evaporation of the water and carbonic acid.) I think the segregation of diatoms may have formed the centres of attraction for the lime when assuming the solid form, and, as probably the heating of the water would cause the separation of the lime, the same cause would ensure the solution afterwards of the siliceous particles.

We know that these rocks have been deep in the earth's crust since their original formation, and sufficiently deep to be within the influence of intense heat, so that we are not likely to find the diatom structure now, unless in very recent formations.

The foregoing remarks, if near the truth, would indicate that all oolitic rock structures have been produced in warm and probably shallow seas.

PAUL L. SMITH.

As regards the formation of Oolitic Limestone, see Lyall's Elements of Geology, 6th Edition, p. 426.

W. H. BADDELEY.

BOTANICAL.

Spyridia filamentosa.—In Pl. 40, Figs. 2, 3, 4, will be found a drawing of this pretty Alga. The form of its delicate cells has somewhat tried my powers of imitation. The red algæ, when subjected to heat, turn *olive-green*, thus, I think, proving the colouring matter of these two great classes of marine algæ to be nearly identical.

I think *Spyridia* is nearly allied to *Polysiphonia;* if so, it has two kinds of fruit—one, the capsule shown in drawing; the other, clusters of spores on the ends of the branches. I would think that the delicate fringed ends of some of the branches represent these, only, if I remember aright, the two kinds of fruit are developed at different times of the year. I have never found the two sorts on one plant.

H. M. J. UNDERHILL.

The proper position of this seaweed amongst Algæ is as follows :—

Sub-class II.—RHODOSPERMEÆ.
Order 13.—**Ceramiaceæ.**
Genus LXXXIII.—*Spiridia.*
Sp. 239. . . . . *filamentosa.*

The only British species of this genus, although it has several synonyms.

" This plant, which is very local on the British coasts, although found in considerable abundance in a few places, is interesting in a geographical view, being a native of warm latitudes, and reaching to its northern limit in this country. Until very recently, when Mr. Ralfs discovered it on the Welsh coast, it had only been found in Britain on the extreme southern shores. It is more plentiful in the Channel Islands and along the French coast, and abounds in the Mediterranean ; but the finest specimens are found in the tropical oceans. In Britain it is generally much discoloured, being of a dirty grey or brownish cast, a deformity caused by its growing in comparatively shallow water, and in places exposed to strong sunshine. *Spiridia* is from a Greek word signifying a ' Basket.' "

J. CARPENTER.

Seeds.—All the seeds of the " Catch-fly " tribe form beautiful microscopic objects, and are well worth the attention of our members.

J. CARPENTER.

ZOOLOGICAL.

Wheat-Eels (Anguillula tritici).—Shortly before his death, our lamented friend, Mr. A. Nicholson, circulated a slide containing these creatures in three stages of their existence, viz.—the egg in various states of development ; the eel as it leaves the egg and spends the first portion of its life ; and the eel in its final state after a period of torpidity. For an account of these Eels, Mr. Nicholson referred the members to a short article written by him in *Science Gossip*, March, 1867, in which he says, to rear these creatures, " I proceed thus :—After selecting about eight grains of *good* wheat, and an equal number of the infected ones, I wrap them in pairs in small pieces of paper, and thus plant them in my garden. Here the damp earth causes the good grain to vegetate, and at the same time resuscitates the eels; and as the wheat-plant grows, they enter the fibrous roots, and passing up the stem enter the ear and deposit their eggs. It is somewhat difficult to detect them in the stem; for this purpose, I take a stem long before there is any appearance of the formation of the ear, and cut very short sections, which I bruise in a drop of water, on a glass slide; but the more easy and pleasing part of the process is to watch them in the infected grain, from their first entrance to their maturity. To do this, it is requisite to have the wheat growing close at hand, so that daily access to it can be had, and the time I recommend for commencement is as soon as the grain begins to form in the ear. The first object to be sought is the parent eel filled with eggs. These, when first extruded, are of a dark colour, and opaque, but gradually become more transparent, at which time the young eels will be seen curled up in various figures, and slowly moving round in their shells, from which they ultimately break forth, and continue to live on the farinaceous matter of the grain until all is consumed, when they become torpid, and so remain till brought again to life by means similar to those which gave activity and instinct to their parents.

"With a low power, no difference can be seen between these and the Paste Eel, except the greater activity and varied sizes of the latter. But the difference is very marked when carefully examined by a high magnifier."

A. NICHOLSON.

Wheat-Eels to Mount.—If the eels to be mounted are taken from the black, dried-looking grains of wheat, "The grains will require to be soaked for two days in water, then taken out, cut open, and the contents placed in a watch-glass of water. In two or three hours after, while in water, they will display considerable animation by twisting about; they then, or before if desirable, may be taken out in sufficient numbers, placed on a slide, and mounted in Dean's Gelatine. When this has sufficiently cooled, say from four to six hours, wash off with cold water the gelatine extending beyond the edges of the glass cover, wipe it dry with a cloth, and use the liquid varnish brush, so as to make the gelatine air-tight, which will soon dry on; cover this with black asphalt. You will then have a very nice neat slide."

J. J. FOX, in *Science Gossip*, 1867.

Sertularia; Sea-Fir; Oyster-Grass.—The name, Oyster-grass, though perhaps only a local one, is descriptive of its usual place


1
2
3
4
5
6
7
8
9
10
11
12
13
a
c
d
t
m
ec.
bc
en

of residence, namely, attached to the shells of oysters, and although the dependence in this case is purely a mechanical one, this is a first step towards parasitism.

But the Sea-Fir has an additional interest attached to it beside that of parasitism, both from its structure and development. The casual wanderer along the sea-shore, picking up a branch of this zoophyte, would at once place it among the sea-weeds, and would look very doubtfully upon the naturalist who informed him of its real nature, so plant-like is it in its manner of growth.

On reference to Pl. 43, Fig. 13 (which gives a fair illustration of its general appearance), it will be seen to consist of stem and branches; upon the branches (Figs. 10, 11, 12) are borne little cups, each containing a hydra-like animal. A section of the stem and branches (Fig. 1) shows that both are hollow, and in free communication with the cups.

Plate 43, Fig. 1, gives a diagrammatic section of Sea-Fir, showing its structure. Outside is a horny covering (*c.c.*), which supports the entire organism, and which expands to form the cups (*d.d.*), in which the little animals reside. Each animal possesses a mouth (*m.*), surmounted by tentacles (*t.t.*), the mouth leading to a simple body-cavity (*b.c.*), in direct communication with the stem (*a.a.*). The layers consist of an Ectoderm (*ec.*) and Endoderm (*en.*); the arrows show the communication.

Through this channel each polype ministers to the general nutrition of the colony, and draws its own food-supply from the common fund thus formed.

Development.—From certain receptacles (Figs. 2, 3, 4), which are developed upon the branches, true eggs (Fig. 5) are discharged into the water. Each egg at first swims freely in the water, but afterwards settles down (Fig. 6), and prepares to fulfil its function as founder of a new colony, and as a first step throws out a bud (Fig. 7), which becomes a single animal (Fig. 8), and as soon as this is fairly started in life it begins to bud. These buds remain attached (Fig. 9), and in turn produce other buds, thus developing the plant-like form of the polype. For the illustrations on the development and structure, and for much of the matter in the above Notes, I am indebted to "*Science for All*," Vol. II.

J. W. Measures.

Holothuria.—This word, literally translated from the Greek, means "all-doory," so that the Greek and English equivalents are remarkably similar, and the German word would be "all-thürig." I should therefore suppose (for I do not know the animal), that it is covered with little doors; but what *are* the doors? Are they the plates, or are they the little holes with which the plates are perforated? The knowledge of the etymology of a scientific term invests it with meaning, so that it is no longer "a horrid crack-jaw word," and when it resembles its equivalent in our own language, it can be more easily remembered.

F. J. ALLEN.

The *Holothuridæ* belong, according to Pascoe's "Zoological Classification," to the sub-kingdom ECHINODERMATA, which is divided into four classes:—

Body-stalked ... ... **Crinoidea.**
Body not stalked.
An external shell of calcareous plates **Echinoidea.**
No shell.
Body lobed or stellate ... ... **Stellerida.**
Body elongated or vermiform ... **Holothuroidea.**

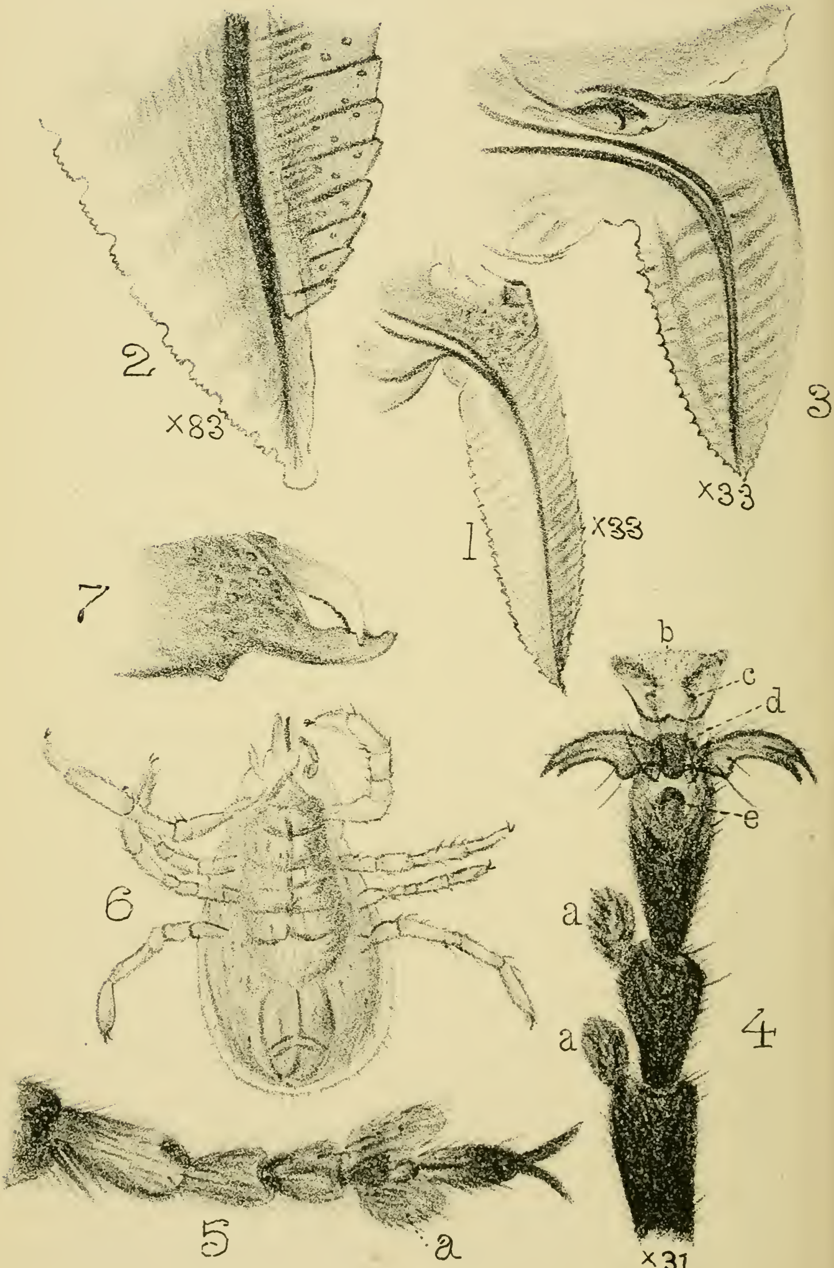
The Sea-Cucumbers (their vulgar name conveying a fair idea of their appearance) differ from the *Echinidæ* in having soft flexible bodies, instead of a hard shell or test. The skin is full of curious plates, which vary in different species, from irregularly-shaped spicules resembling those of *Gorgonia*, to the beautiful and well-known ones from *Synapta* and *Chirodota*, both of which latter belong to this class, *Holothuroidea.*

H. E. FREEMAN.

Mite from Gamasus Coleoptratorum, taken from Humble-Bee. An account of this mite, with figures, will be found in "*Science Gossip*," 1879, p. 81. Since that article was written, I have tried another plan for finding them without killing the bee.

Having caught your bee, place it under a wine-glass; then moisten a bit of blotting-paper with a drop or two of chloroform, and introduce it under the glass. Before the bee is perfectly stupified the Gamasi will quit it, and may be picked up with a damp brush, and placed in the live-box or hollow slip; whilst the bee, if put in the sun, will recover and fly away relieved of its parasitic companions. My friend, Mr. Michael, had some Gamasi obtained from a Humble-Bee preserved in spirit, and he tells me that after he had seen me he examined them, and found the mite. I do not think the mite is a *Hypopus;* indeed, I think it requires a new name, (if it be not altogether a new genus,) but perhaps time and patience will clear up this matter.

C. F. GEORGE.


2
×83
3
×33
1
×33
7
b
c
d
e
a
6
a
4
5
a
×31

Labidostomma luteum (Plate 42, Figs. 6, 7).—This mite is new, not only to Britain, but to the scientific world, having escaped even the lynx-eyed Koch. It was first described by Kramer in "Archiv. für Naturgeschichte," 1879, and, so far as I know, has only been found in England by Mr. Michael, F.L.S., and myself. Kramer made a new genus of it under the name *Labidostomma*. I might write a long description, for it is very peculiar in many respects. When alive, it walks like a *Gamasus*, using the first pair of legs as feelers; but it will be noticed that these legs, instead of being long and *thin*, are long and *thicker* than the other legs. It also possesses very curious and immense chelate mandibles, but these are not extensile, as in *Gamasus*; and it has on the shoulders two convex prominences, very much like eyes. It is covered on its surface with very beautiful reticulations, the raised edges of which are themselves also minutely marked. To see it to perfection it must be alive, for it has four very fine, curiously branched, pale yellow tactile hairs, which cannot be seen after mounting, but which are very easily found in the living creature. Indeed, two or three very beautiful slides may be made out of its parts when dissected, the chelate mandibles in particular, the immoveable claw being furnished with a curious notch near the end, into which the moveable one catches (Pl. 42, Fig. 7). The fore-legs are furnished with a pair of claws, but the other legs have a tridactyl tarsus, with the centre claw much larger than the two others, as in Fig. 27. This cannot be well seen in the mounted specimen. The genital plates are also very curious, as will be seen by the drawing in Pl. 42, Fig. 6.

Fig. 27.

C. F. George.

Earwig, Forficula auricularia.—The class Insecta has three sections, viz.:—

1.—Ametabola, which undergo no metamorphosis.

2.—Hemimetabola, which undergo an incomplete change.

3.—Holometabola, which undergo a complete change.

The *Larva* of the Hemimetabola is nearly similar to the *imago*. The *Pupa* is not quiescent, and has only rudiments of wings. The *Imago* has perfect wings. The Hemimetabola form three orders, viz.:—1.—Hemiptera. 2.—Orthoptera, 3.—Neuroptera. The Orthoptera are characterised by having—

1.—The *posterior wings*, folded in radiating lines like a fan.

2.—The *anterior wings* covered with chitine.

3.—The *mouth* masticatory.

Of the Orthoptera there are two sections :—

1.—*Cursoria,* which run ; 2.—*Saltatoria*, which jump.

The *cursoria* have their legs all alike, and fitted for running. There are four families, viz. :—

1.—*Forficulidæ*—Earwigs.

2.—*Blattidæ*—Cockroaches.

3.—*Mantidæ*—the Mantis family.

4.—*Phasmidæ*—Leaf Insects.

The *Forficulidæ* have four distinguishing features :—

1.—The Wings, when folded, are disposed horizontally on the body.

2.—They are furnished with two corneous forceps-like appendages at the hinder extremity of the body.

3.—The Antennæ are slender, filiform, inserted before the eyes, and vary considerably as to the number of their joints.

4.—The Thorax is of a rounded form, and slightly convex.

The name Earwig may be derived from the Saxon *Wicga*, a worm, or from the Saxon *rigga*, to bore or pierce, and sometimes used when speaking of a meddlesome person as an "earwig," or when anyone is threatened with an "earwigging."

On the continent the tradition is similar to our own, that Earwigs creep into men's ears, and make mischief in their brains, for they are called in France, *Perce-oreille*—ear-piercer; Germany, *Ohrwurm*—ear-worm; Italy, *Pinzainola*—little piercer.

Earwigs prefer damp situations, and are found under stones, bark of trees, flowers, etc., the latter of which they destroy by eating; their province in nature seems to be to eat voraciously all kinds of vegetation. I had one that having changed its skin was evidently eaten by its companions.

The female sits on her eggs, like a hen, and the young resemble the parent, except in being of a paler colour, and have no wings or elytra, and as soon as they are hatched creep under the body of the mother for protection, as young wood-lice do.

The wings are transparent, and of large size, and when expanded are shaped like a fan. The principal nervures radiate from a point near the anterior margin. When not in use, the wings are folded beneath two horny cases.

The anal forceps of the female are less curved and are destitute of the tooth-like processes which are observable on the inner side of the base of the forceps of the male. Their use is to help in folding up the wings and to pack them under the elytra. They *may* also serve to frighten their enemies by the fierce appearance they give to their harmless possessor.

The wing, when expanded, resembles somewhat the human ear, whence the name *Ear-wing*, shortened or corrupted into Earwig, may have been derived. When closed, it is for one-third of its length folded upon itself, so as to be easily packed beneath the very short elytron, and it is very difficult to unfold it for mounting by reason of its extreme delicacy, and the elasticity of its ribs.

The elytron-hooks of the Earwig have been mounted by "the profession," and sold as *gastric teeth*, but their position clearly shows their use. We find that they are interlocking organs, situated in rows under the elytra, and are studded with numerous minute spines, which hook upon a similar row on the under-surface of each elytron.

F. B. Kyngdon.

Earwig.—I had always laughed at the idea of these insects getting into the ear, until a few years ago, when it occurred to my own son. He was found crying one evening in bed with pain in his ear, and his mother saw it bleeding, and something in it, which she extracted with a hair-pin, and found to be a live Earwig. I suppose it must have bitten the skin, as I do not think the anal pincers capable of drawing blood. I have never met with any other reliable instance of an Earwig in the ear. Perhaps other readers may know of such, but I fancy it is not at all common for insects to stop in the ear. In the above case no harm was done.

I was once holding a large Garden-spider in my hand, when it bit me close by the side of the nail, and almost drew blood, rather to my surprise.

W. Locock.

The maid-servant of a friend once had an Earwig in her ear, which caused most excruciating pain. Her master quickly dislodged it, by soaking a small piece of tobacco in brandy, and squeezing a drop from it into the ear.

Editor.

Hilaria cilepes.—I would take the opportunity to call attention to the position of the abdominal spiracles, viz., in the centre of the breadth of each abdominal *ring*, and not between the *rings* as opposed to their position in the thorax of insects, where they occur *between* the segments. It may be remembered that I have before made use of this, as one of my reasons for thinking that the posterior dorsal portion of the thorax in Hymenoptera is abdominal, as, what is sometimes called (incorrectly, I believe,) the meso-thoracic spiracle in this order is always *on* the dorsal surface, and not between the segments. A spiracle *on* the dorsal surface of a thoracic segment is, so far as I am aware, unknown except in this order, and the anomaly is only to be explained by regarding the surface on which it occurs as abdominal, or, to use Newport's more correct phraseology, thoracico-abdominal. It is, to coin a somewhat awkward term, post-meta-thoracic, a segment *ventrally atrophied* being only developed on the dorsal surface, and there subtending the posterior ventral surface of the meta-thorax. The phenomenon is so far from being exceptional that I have succeeded in tracing it in, I think, every instance where I have taken the trouble to look for it. Let anyone look for it in *Goerius olens* after removing the wings and elytra, and he will find it a precisely parallel case—a distinct dorsal plate posterior to the wings, with a spiracle on each side in the *centre* of its breadth, yet joined to the posterior ventral portions of the meta-thorax, having no ventral arc of its own.

A. HAMMOND.

Flea from Wild Rabbit.—The enlarged antennæ make this flea very much resemble that from the mole, but the eye of the former is quite distinct, unlike the Mole-flea, where the organ, if not absent, is at any rate invisible in all my slides from that animal. The lancets of the Rabbit-flea are unusually large, and the teeth remarkably strong.

H. E. FREEMAN.

Antennæ of Flea.—I have several times seen these organs erect in the *male* insect, more especially, I think, among *Mole-fleas*. Has any member seen a female with erect antennæ?

C. F. GEORGE.

Leg of Glow-Worm.—I should be glad to know the use of the membrane marked *a* (see Pl. 42, Fig. 5).

H. BASEVI.

Glow-Worm.—I do not know for a certainty what is the use of the membranous pads on the foot of the Glow-Worm, but they are evidently the same parts as the pulvilli of the Diptera, which, as is well known, are furnished with viscid hairs to enable them to walk on vertical or smooth surfaces. It would be rash, however, to assume that their use is the same in other insects. What a curious appearance the cancellated structure of the thorax of this insect presents!

A. HAMMOND.

Glow-Worm.—With regard to the legs of the male Glow-Worm, is it not the penultimate joint of the tarsus which is bilobed, this being one of the characteristics of *Lampyris noctiluca*? Many other beetles have the same double-joint.

C. F. GEORGE.

Saws of Saw-Fly.—I append sketches (Pl. 42, Figs. 1, 2, 3) from two specimens in my own collection. By comparing Fig. 1 with Fig. 3, the way in which the saws *perhaps* work up and down the back pieces may be understood. I say "perhaps" because I fancy that the two parts of the saw are kept fitted together, as in Fig. 3. However, at any rate, the back of the actual saw is grooved, and in the groove the back piece can be moved, as will be seen in Fig. 2, which is the tip of Fig. 1 more highly magnified. These back pieces, in many respects, are toothed as in Figs. 1 and 2, while in some they are only minutely serrated, as in Fig. 3. The elaborate construction of the teeth of the saw is wonderful, and the careful comparison of many species is a most interesting study. Fig. 2 shows that each tooth is serrated, and somewhat strengthened by the chitine of the blade being thickened in transverse lines. In Fig. 3 the teeth are not serrated, but the strengthening is more curious. Each tooth is, as it were, on a rod or bar of chitine. These rods spring from a thickening of the chitine, which runs all down the blade, and this again is supported by other bars springing from the strong rib of the saw, which reminds one strongly of the piece of brass affixed to a carpenter's tenon saw. The rib can be plainly seen in Fig. 2.

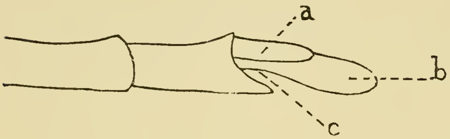
It used to be said that the fly laid the egg by passing it between the two saws. This account was shown to be incorrect by a paper in "Science Gossip" a few years ago. It is easy to find the real ovipositor as there drawn.

H. M. J. UNDERHILL.

Saw-Fly.—To illustrate the structure of the Feet of Saw-Fly, I add a drawing of the foot of a species of *Allantus* (Pl. 42, Fig. 4).

In preparing feet with potash, the soft part, *b* (see plate), is very liable to be dissolved away. The soft part of the pad is supported by a stiff concave rib, *c*, to which the muscles are probably attached, and the pad can be partially retracted into a socket, as in the annexed diagram (Fig. 28) in which *a* represents the stiff part; *b*, the soft part; and *c*, the socket. There is a dark spot, *e* (see Fig. 4 in plate), near the part where the claws and pad are joined, which, I think, must be due to a thickening of the chitinous integument for the purpose of strength, because this part must necessarily be strong. The slide from which this drawing was made, not having been treated with potash, has retained in a great degree its natural form and colour, although in mounting, the pads *a a* have come round to the side from underneath, through the twisting of the joints to which they are attached. But if they had not twisted, they would have been invisible.

Fig. 28.



F. J. ALLEN.

Palate of Doris.—This fine Palate [**Odontophore**, ED.] is obtained from one of the NUDIBRANCHIATA, the popular name of which is "Sea-Lemon," and here (as in the case of Sea-Cucumber) the resemblance is strikingly suggestive. The Sea-Hare (*Aplysia*) is a synonym equally applicable to one of the TECTIBRANCHIATA. Some fine Nudibranchs are to be seen at the Crystal Palace Aquarium, and probably also at Brighton, but they may be easily overlooked, owing to their peculiar shapes, even when two inches in length. There are some good figures of these in Gosse's "Mollusca" and in Carpenter's "Zoology." The palates of *Æolis* are exceedingly beautiful, especially with the polariscope.

H. E. FREEMAN.

Palate of Cyclostoma elegans.—This is a land Snail, which burrows underground. It may sometimes be found (alive) by digging on limestone hills, but even in places where I have picked up the empty shells three and four at a time, I have searched in vain for a living animal. The colour of the shell is grey, it is slightly mottled, and the shell is striated in the direction of the spiral. It has an operculum, and is nearly allied to the common *Paludinæ* and *Bithyniæ* of our ditches.

H. M. J. UNDERHILL.

Palate of Whelk.—These teeth are simply cutical papillæ, having, of course, special forms, and solidified with earthy material, but otherwise homologous with the processes on the tongues of Felidæ and Herbivora.

TUFFEN WEST.

Hair of Deer.—As the Hairs of all the varieties of Deer which I have examined are alike, the specific name is not necessary. The peculiarity in the hair is that, starting from a very shallow follicle and having an extremely attenuated stem, this becomes expanded almost suddenly into a singular pith-like substance, every cavity of which contains air. By this contrivance, the hair becomes a bad conductor of heat, and keeps out the cold of winter, without such an addition as the great coat that we have in sheep. There are many other hairs into which air enters largely, sometimes in closed cavities, as in the Hare, sometimes in communicating cells, each set of which is separated from its neighbours above and below, as in the rat and mouse.

T. INMAN.

Liver-Fluke.—Agassiz discovered that a genuine *Opalina* was hatched from the egg of a *Distoma*. *Opalinæ* are found in the fæces of animals affected with liver-flukes, and they pass out with the bile. Sewage-water develops them, and the young embryos swim by means of cilia. They die in pure water. A metamorphosis of a complicated nature takes place. In the cavities of frogs, snails, fish, mussels, &c., they live as parasites for a time, and then the cilia are discarded. They fix themselves, and are oval, motionless bodies for a time. Out of each a *Cercaria* arises. The *Cercariæ* have been found in the biliary passages, underneath the skin of the foot, and in a cyst behind the ear of a sailor. The eating of uncooked food, such as fish, whelks, and vegetables, affords a ready means for their reception. From *Cercariæ* the Flukes are developed.

H. BROWN.

There is some doubt as to whether *Opalinæ* represent a stage in the development of the Fluke. I have consulted the latest authorities, and find them by no means positive on this point.

Van Beneden says they abound in the lower bowel of frogs, and also in various Annelids, their office being to act as scavengers, by feeding on the fæcal matter even before it is expelled.

At another part of the same work, "Animal Parasites and Messmates," the author describes the development of the Fluke, saying that the eggs, which are extremely numerous, each hatch into a ciliated infusorial (which, however, he does not identify with *Opalina*). These infusorial organisms swim about freely for a few days, then lose their cilia, and crawl about slowly. They have all been deposited by the parent Fluke, either during its lifetime, or by being liberated by its decomposition when dead. They are dispersed in various ways and many perish, but some gain an entry into the body of what is to serve as their host, where they undergo further development. This host is generally a Mollusc, in whose body the larva develops other larvæ of altered character, which are now called *Cercariæ.*

These escape from the body of the Mollusc, which has been their intermediate host, and again swim freely in the water. Afterwards, they again enter the bodies of other Molluscs, a feat which they accomplish by means of a boring-apparatus, and having previously cast off their tails, they become encysted under the skin. Here they change from the larva into the pupa state, and are afterwards transferred with the fodder or drink to the digestive organs of their future victims. The gastric juice dissolves the cyst and sets free its inhabitant, which is now able to make its way into various parts of the digestive organs, and when mature discharges its eggs, to again go the same wonderful round.

With regard to *Opalinidæ*, mentioned at the beginning of this article, Savile Kent states that there would appear to be a relationship between them and a certain stage of the development of some Cestoid worms, but that at present there is not sufficient evidence of their identity,

I will finish by quoting Dr. Cobbold's estimate of the possible number of these parasites which may be derived from one diseased sheep.

He says:—"A single sheep may harbour 1,000 Flukes; each Fluke will develop 10,000 to 40,000 eggs; and each egg may give rise to 370 *Cercariæ.*

"Thus, one Fluke might originate between three and four millions of these life-forms, and one sheep might be the means of producing at least 3,000,000,000 (three thousand millions).

"By far the larger portion of this immense number perish before coming to maturity; but still enough of them survive to destroy thousands of sheep annually."

GEO. D. BROWN.

EXPLANATION OF PLATES XLII. AND XLIII.

PLATE XLII.

Fig. 1.—Saw of a common Black Saw-Fly, mag. 33 diam.

,, 2.—Tip of the same, mag. 83 diam., showing serrature of the teeth, and groove in which the back-piece works.

,, 3.—Saw of another Saw-Fly. Teeth not serrated, showing the curious mode in which they are strengthened by the thickening of the blade in certain bars. Drawn by H. M. J. Underhill, from specimens in his cabinet.

,, 4.—Foot of a large Green Saw-Fly, (*Allantus,*) mag. 31 diam. The pads, which, in their natural position, are on the underside of each joint of the tarsus, have become distorted in mounting, and are shown on the left-hand side of drawing. *b*, soft and probably adhesive portion of the terminal pad; *c*, hard part of the same pad acting as a lever, to which muscles are attached; *d*, projection under the foot forming a socket into which the pad may be partially withdrawn; *e*, thickening of the chitine. Drawn by F. J. Allen.

,, 5.—Hind leg of Glow-Worm, ♂. The organs marked *a* are those respecting which information is asked.

Drawn by H. Basevi.

,, 6.—*Labidostomma luteum.*

,, 7.—One of the chelate mandibles of the same.

Drawn by C. F. George.

PLATE XLIII.

Fig. 1.—Sectional diagram of the Sea-Fir (*Sertularia*): *c.c.*, the horny covering which supports and gives strength to the entire organism, and which expands to form the horny cups in which the little animals reside; *m.m.*, the mouths surrounded by tentacles *t.t.*, lead into a simple body-cavity, *b.c.*; *ec.*, the ectodern; *en.*, the endoderm layers of the body; *a.a.*, the hollow into which the body-cavity of each separate animal leads, thus forming a free communication with the whole colony.

Figs. 2, 3, 4.—Receptacles, in various stages of maturity, developed on the branches of the *Sertularia*, from which true eggs are discharged.

Fig. 5.—A free-swimming egg in two stages.

,, 6.—An egg settled down.

,, 7.—A bud-like projection developed from it, and growing into

,, 8.—A single hydra-like animal, which becomes the founder of

,, 9.—A new colony,

,, 10.—Small portion of *Sertularia abietina*, mag. 25 diam.

,, 11.—Small portion *Sertularia pluma*, mag. 25 diam.

,, 12.—Small portion *Sertularia lendigera*, mag. 25 diam.

,, 13.—Portion of *Sertularia*, as it appears to the naked eye.

Review.

THE POLYCLINIC: a Monthly Journal of Medicine and Surgery *(P. Blakiston, Son, and Co., Philadelphia, U.S.A.)*.

This is a new Medical Journal, of which we have received Nos. 1 and 2. Among the articles of interest is a valuable continued paper on One Hundred Cases of Skin Diseases, by Arthur Van Harlingen, M.D., in which the various treatments are described. This Journal is addressed to the medical profession.

Current Notices and Memoranda.

The Sucking-Organs of Bees, Bugs, and Flies.—Dr. K. Kræpelin has described in the *Zoölogischer Anzeiger* the mouth-organs of the Bee and certain Hemiptera and Flies. In the Humble-Bee the tube is composed of the labial palps and the maxillæ, which are connected with them by strips of chitinous substance; near their lower margin the paraglossæ intervene between the palps and the maxillæ. The half-canal formed by the upward curve of the margins of the labium gradually disappears towards the posterior part of the latter, and allows liquid which has passed down it to escape between the labium and maxillæ into the mouth, at the point of origin of the paraglossæ. Besides the tactile hairs, certain peculiar clavate pale hairs are placed on the apex of the labium, which appear, from observations, to be analogous to the olfactory hairs of the inner pair of antennæ of Crustacea, and, as they carry a minute opening at their ends, must be considered as either gustatory or olfactory organs.

Like that of Butterflies, the sucking-tube of the Hemiptera is made up exclusively of the two maxillæ, which unite in such a way as to form a double cylinder, the upper division of which carries the food, the lower the salivary secretion. The mandibles lie by the side of the maxillæ, and can move about on the tube. The end of the labium is provided with terminal nervous organs. In the proboscis of Diptera the sucking-tube is formed mainly by the labium, which consists of a demi-canal, closed below partly by the mandibles, which are connected with it by a groove-and-ridge joint, and partly by the hypo-pharynx, which runs below the mandibles, carrying the salivary canal; on each side below the hypopharynx lie the maxillæ.—*Am. Nat.*

Mr. Edmund Wheeler, of Tollington Road, Holloway, has favoured us with a parcel of very beautifully prepared slides, comprising Geological, Botanical, Entomological, and Anatomical subjects, amongst which are fine sections of Limestone Rock from Norway with Diatoms in situ, and of Barbadoes Rock with Polycistina in situ; Fossil Diatoms from Nottingham, U.S.A.; portion of a Leaf of *Drosera rotundifolia*, with several captured insects, some of which appear to be partially digested. The sting and poison-gland of Hornet: in this slide the gland and poison-duct are stained blue, whilst the chitinous barbs and sheath remain of a rich brown colour. Section across the forehead and through the two eyes of *Eristalis tenax:* this is a very beautiful slide, the bacillar structure leading from the cornea to the optic ganglion being most perfectly cut. Indian Mosquito from S. Mahratta. Amongst the Anatomical slides are:—Double-stained Blood-discs of Frog, showing the nuclei; Cerebellum of Monkey, injected and stained; Sections of Toe of White Mouse, and Tongue of Cat, both injected; and a Section of Human Small Intestine, admirably prepared, showing the Villi and Goblet cells.

We have received from Mr. H. P. Aylward, of Strangeways, Manchester, a set of Apparatus for Pond-Life Hunting, which appears well adapted for the purpose. The bottle-holder is a coil of steel wire made to grasp the neck of the bottle, the other end of the wire being a spiral hollow screw, in which the taper end of any sized walking-stick may be inserted and held securely. The dipping-bottle packs in a neat japanned cylindrical tin box, the upper half of which is composed of very fine copper gauze. When the bottle is emptied into this box, the animalculæ will be retained in the lower part, and the surplus water escape through the gauze. This operation may be repeated any number of times, and the contents afterwards returned to the bottle. For special gatherings, another japanned box is supplied, containing several large test-tubes securely corked. The size of cylindrical box and its case containing the bottle is 5 inches long by 2 inches in diameter; that of the box with test-tubes, $5\frac{1}{2}$ inches by $3\frac{1}{2}$ inches by 1 inch. They may be carried very conveniently in the coat-pockets, and should always accompany the microscopist in his country rambles.

Mr. W. P. Collins, 157, Great Portland Street, has sent us a forward copy of his October Catalogue of Scientific Books, relating in the present instance mainly to Microscopy and the

Allied Sciences. To give an idea of the varied contents of this catalogue, we notice books relating to the following special branches of microscopical literature :—Algæ, Bacteria, Desmids, Diatoms, Entozoa, Foraminifera, Infusoria, Medical Microscopy, Micro-Biology and Physiology, Micro-Botany, Micro-Chemistry, Micro-Geology and Natural History, Micro-Photography, Optics, Sanitary Investigations and Adulterations, Zoophytes, etc. Book-buyers will do well to consult this catalogue.

We are sorry to receive from our friend, Mr. E. Wade-Wilton of Leeds, a letter, in which he informs us that he has been ill for nearly eight months. We are, however, glad to find that by his doctor's orders he is now endeavouring to regain health, and if possible, new life, by killing salmon and trout in the lakes of Westmoreland and Cumberland. We regret to learn that his sight is somewhat impaired, and that in consequence he is unable to accept any new subscribers for his series of living objects; but he hopes shortly to devote his time to the supply of such animal and vegetable specimens as will be suitable for Biological Class illustration, and as we believe him to be an experienced and careful naturalist, we think that those who require such slides will do well to write to him.

The Annual Meeting and Dinner of the Members of the Postal Microscopical Society will be held at the Holborn Restaurant, High Holborn, on Thursday, October 11th, at half-past six p.m. It is hoped that we shall have a good attendance.

Exchange.—I offer Fossil Diatomacæ from Franzenbad, Bohemia, and Fossil Material from the Vienna basin, containing Foraminifera (*Amphistegina* D'Orb), and shall be glad to receive in exchange Zoophytes, Gorgonia and Sponge Spicules, Holothurian Plates, and Diatomaceous deposits from Nottingham, Barbadoes, and Richmond, U.S.A.

J. C. Rinnböck,
14, Simmering, Vienna, Austria.

Exchange.—I offer Fossil Sand from Saucat's tertiary deposits, containing well-preserved **Foraminifera, Shells, Corals, & Spicules** (any quantity), in exchange for good mounted slides.

E. Rodier,
61, Rue Mazarin, Bordeaux, France.

Errata.—P. 27, line 10, for *Arachnoidiscus* read *Chondrus;* p. 120, line 9, for *purpoides* read *pupoides.*

List of Plates.

Index to Vol. II.